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EXCISION OF THE SUPERIOR HYPOGASTRIC PLEXUS (PRESACRAL NERVE) FOR PRIMARY DYSMENORRHEA

JOE VINCENT MEIGS, M.D., F.A.C.S., Boston, Massachusetts

FROM 1898 till 1924 attempts were made to relieve pain in the pelvis by section or excision of sympathetic nerves. Periarterial sympathectomy was attempted by Leriche with some measure of success. In December, 1924, Cotte first performed the operation known as "presacral neurectomy." His patients' relief of pain was immediate and satisfactory so that in 1925 he reported his operation and its success. Since then many reports in foreign and domestic journals testify to the soundness of Cotte's operation. There have been few admitted failures and no report of sequelæ from excision of this part of the pelvic sympathetic system. The mortality is said to be almost nil and the operation reported as easy. Cotte emphasized certain definite types of cases that might be expected to be relieved by his operation and it is obvious from perusing the literature that few have deviated from his original standards. He reported in 1930 that the presacral nerve is one that spreads out exclusively in the pelvis and vaginal regions and that resection of this plexus of nerves is a cure for "plexalgia hypogastrica." This last term includes dysmenorrhea, dyspareunia, causalgia of the vagina, pelvic neuralgias, and pruritis vulvæ. It is definitely of no use for lumbar pains (ovarian dysmenorrhea) or ovarian intermenstrual crises. But for pain referred to the uterus and radiating to the anus, coccyx, and urinary bladder, a properly done operation should be followed by a 100 per cent relief.

Various names are connected with the attempt to solve the problem of pelvic pain and a few follow: Jaboulay, 1898; Ruggi, 1899; Leriche, 1921; Cotte, 1925. These men all contributed to the ground work of the operative procedure while Latarjet and Bonnet named the main nerve branches of the sympathetic system of the pelvis the "presacral nerve." Hovelacque re-named this nerve area and more properly called it the "superior hypogastric plexus." Later Elaut, Fontaine, and Herrmann, in 1932, contributed studies both anatomical and experimental to the problem.

In 1933, Davis undertook careful studies of the nerves themselves removed at operation for relief of pain. Cotte first suggested the possibility of an inflammatory process in the region of the pelvic sympathetic nerves as the reason for pelvic neuralgias, and the work of Davis substantiates it. One reason, among many others, suggested for pelvic neuralgias and for dysmenorrhea is that mild inflammatory processes are found affecting the connective tissue and the nerves themselves with degeneration occurring in the ganglion cells.

From the Surgical Service of the Massachusetts General Hospital.

MATERIAL

This paper is the report of a series of cases in which patients were operated upon at the Massachusetts General Hospital under a special assignment begun in 1931. In 1930, Dr. J. C. White, of the neurosurgical department, and the author performed the first excision of the superior hypogastric ganglion at the hospital. This patient was followed for over a year before a second patient was operated upon as it was felt that careful observation was imperative. Except for a mild recurrence of her dysmenorrhea 5 years later, she remained quite satisfied and well up to her last visit to our clinic. From then on in increasing numbers neurectomies have been done by the author and the relief of pain has been great, though *not* 100 per cent. Failures can be attributed to lack of excision of sufficient nerve tissue and to poor selection of cases. It was the feeling of Dr. White and the author that 20 cases should be done in which no other operative procedure was carried out other than the removal of the plexus, this in spite of retroversion or flexion or other pelvic pathology. This was felt to be necessary to support the theory that removal of the nerves effected the cure and not other operative procedures, such as dilatation, suspension, and resection of ovaries. Six other patients were operated upon by the author and one by Dr. White, and in these dilatations, suspensions, cauterization of the cervix, etc., were carried out in addition to the neurectomy. These two series will be analyzed later in the paper.

In our group the operation was done for what was considered primary or functional dysmenorrhea and not secondary dysmenorrhea or that due to some other pelvic pathology. No attempt has been made to test the efficiency of the operation in cystalgia, dyspareunia, or metastatic or extensive malignancy.

DYSMENORRHEA

What causes the pain of dysmenorrhea? This has been answered by Cotte as being due to a mild inflammatory process in the nerves themselves. There are many other possibilities, such as ischemia of the uterus due to a vasoconstrictor action upon the vessels (whether due to nerve or hormone control, or both, it is not possible to say). The pain may be due to violent contractions of the uterus against a very tight cervix, definitely one real reason for pain; for who has not tried to dilate the cervix of some patients with dysmenorrhea only to find that it is almost impossible? One of our failures took place in such a uterus and it was necessary to try for an hour before the opening of the cervix could be probed, and then only with the smallest silver probe. On the other hand not all cases are due to a tight cervix, as all of us are familiar with the ease with which many cervices can be dilated in patients with severe dysmenorrhea. Hormonal causes are certainly possible especially since Kurzrok's latest work shows that progesterone causes deep contractions of the uterine musculature. When we remember that all patients with dysmenorrhea ovulate, the importance of this observation upon progesterone becomes manifest. Large doses of estrin check dysmenorrhea, the mechanism being in some way connected with the prevention of ovulation. Studies upon this phenomenon will be reported shortly by Sturgis and Albright of the Massachusetts General Hospital. However much we look for explanations for dysmenorrhea we are ever conscious of the fact that muscular movement of the uterus and dilatation of the cervix must be considered of prime importance, for the pains of labor and the pains that occur during miscarriage are similar to dysmenorrhea. It is very evident to the gynecologist that dilatation of the cervix without anesthesia is painful and that scraping the inside of the uterus with the endometrial biopsy curette causes pain sensations similar to cramps of dysmenorrhea. So that although the definite cause for the pain is not known it is possible to produce it and it is evident that excision of the superior hypogastric plexus will relieve it. Yet the neurectomy will not interfere with the action of the uterus in expelling blood during menstruation, or a fetus at the end of a pregnancy.[1]

[1] A recent observation upon 2 patients who had successful neurectomies is of great interest. These 2 patients, who had never had children, were subjected to endometrial biopsy. This maneuver always causes uterine cramps. The only discomfort noticed was backache on passing the internal os. Scraping of the cavity of the uterus caused a sensation of being touched but no pain. It is possible that there are two types of dysmenorrhea: one, a backache due to stretching of the internal os; and the other, uterine cramps due to irritation within the uterine cavity. The neurectomy relieves the cramps for the nerves conducting pain are removed but it does not relieve the backache.

It must be acknowledged that certain dysmenorrheas are psychic or physical, and the better the condition of the patient's psyche and the better her physical condition the less likely she is to be bothered with pain. Nevertheless the number of patients relieved of true dysmenorrhea by either psychiatrists or hygienists is small. They may make it easier for the patient to bear her pain but they do not, except in a few instances, relieve it. The gynecologist should be on the watch for patients who do not have a typical story of true dysmenorrhea, for the operation will not help them and failure discourages the patient's physician. If it is evident that a patient has no complexes and that her physical condition is satisfactory and the dysmenorrhea is *uterine dysmenorrhea*, then real relief of from 75 to 100 per cent can be expected by removal of the plexus.

Before subjecting any patient to the operation, it is suggested that other methods of treatment be tried first, such as psychiatry; improvement in hygiene; the use of simple drugs, such as aspirin; antispasmodics, such as atropine or belladonna; and dilatation of the cervix. The use of morphine and its derivatives should not be considered. No doubt in the near future there will be reports on the use of hormones but all except huge doses of estrin with its probable effect upon ovulation have proved failures in our hands. It will have to be decided by the individual doctor and patient whether the surgical removal of the nerve is more hazardous than a possible disturbance of the pituitary gland by large doses of estrin. It is better in most instances to advise dilatation of the cervix before an abdominal operation inasmuch as this simple procedure does relieve 25 to 50 per cent of cases for an indefinite period. The presence of a thick muscular band about the internal os, similar to the band about the pylorus in pyloric stenosis of children must be considered. If such a band is felt on rectal examination, it can be split by cutting posteriorly in the cervical canal against the finger in the rectum. This method of longitudinal section of the internal os is important and if the cervix is exceptionally tight the incision should enlarge the os and give relief from pain. The use of the stem pessary is a real possibility as it may be accompanied by a great deal of success and surely the dangers are not too great. This form of treatment can be tried by those who have no objection to it. If at operation a retroversion or flexion of the uterus is found, it is much better to do a suspension and also a neurectomy than it is to find after the suspension that the patient is not relieved of her pain.

ANATOMY OF THE NERVES

"The superior hypogastric plexus is a sympathetic plexus and the preganglionic fibers come from the lowest thoracic and upper lumbar levels of the intermediolateral columns. The cells send their axones out over the lower white rami of the thoracolumbar outflow to the lumbar and pre-aortic ganglia. The postganglionic neurones originate in the sympathetic trunks, as well as in the pre-aortic ganglia, to form a plexus descending along the abdominal aorta. At the level of the inferior mesenteric artery there are two small ganglia and from these a plexus descends the artery to innervate the sigmoid and rectum. The remainder of the descending sympathetic fibers form the superior hypogastric plexus at the bifurcation of the aorta. This plexus divides at the bifurcation of the two common iliac arteries to form two hypogastric nerves that run into the hollow of the sacrum to join the inferior hypogastric plexus. Sensory neurones from the posterior root ganglia in the same segments of the cord run directly into the superior and inferior hypogastric plexus" (White). In other words, from the celiac, semilunar, splanchnic, and mesenteric ganglia sympathetic fibers course down either side of the aorta (the intermesenteric nerves) and often crossing and recrossing the aorta are joined by branches from the lumbar ganglia (Fig. 1). At the region of the root of the inferior mesenteric artery as it arises from the aorta a plexus is found known as the inferior mesenteric plexus. Some of the nerves making up this plexus follow the inferior mesenteric artery to supply the sigmoid and rectum, and others course down over the bifurcation of the aorta to form the superior hypogastric plexus. This plexus lies in the triangle bounded by the two common iliac

arteries and originates at the bifurcation of the aorta and ends at the bifurcation of the common iliac arteries to become the right and left hypogastric nerves. Some fibers follow the common iliac arteries and are intimately connected with them. The left common iliac vein forms the back wall of the triangle and the nerves are often in close association with it. It must be remembered that from under the common iliac arteries branches of nerves from the fourth lumbar ganglia come to join the plexus. All other nerves cross over the bifurcation of the aorta but these two branches are under and must be remembered when doing the dissection. Low down the superior hypogastric plexus lies directly upon the periosteum and perichondrium of the fifth lumbar vertebra and just above the vertical middle sacral artery. The two hypogastric nerves are joined lower down in the pelvis by parasympathetic fibers of the second, third, and fourth sacral ganglia and make up the inferior hypogastric plexuses. These nerves supply the uterus and bladder and end in the uterus in the great plexuses of Frankenhaeuser.

PHYSIOLOGY OF THE NERVES

It has long been considered that the pelvic nerves were motor and carried no sensory fibers, but the success of presacral neurectomy and the great relief of pain increase belief in the presence of sensory fibers. Learmonth's observation supports this view. With a patient under spinal anesthesia he noted that handling the superior hypogastric plexus with forceps caused crushing pain in the bladder. The sympathetic fibers cause vasoconstriction and inhibition of the musculature of the sigmoid, rectum, and bladder and cause ejaculation and contraction of the involuntary sphincters of the bladder. The parasympathetic works in opposition to the sympathetic nerves and causes vasodilatation and release of the various sphincters. It is, therefore, possible to conceive of a better blood supply to the uterus and a release of muscular tone both in the body and the cervix by excision of the superior hypogastric plexus. This alone might account for certain pain relief, but the fact that section of these nerves does not alter (to any great degree) the menstrual function, does not interfere with delivery, does not produce atrophy or cause any disturbances of motor function of the bladder seems to Fontaine and Herrmann to be supportive proof that the genital nerves of the sympathetic systems are sensory rather than motor in nature. The hypogastric plexus carries pathways of sensation from the genital tract to the medullary centers, and excision of this plexus is therefore sound in the treatment of uterine or cervical pain.

Thus we have a system of sympathetic nerves that course through the superior hypogastric plexus and that carry vasoconstrictor fibers to the blood vessels of the uterus and cause contraction of certain sphincter muscles. The nerves also carry afferent sensory impulses to the higher centers. Excision of such a plexus therefore should cause increase of blood supply, lessening of spasm and interruption of pain impulses to higher centers. The parasympathetic in opposition to the sympathetic supply dilates blood vessels and releases sphincters, does not carry uterine pain, but does carry bladder pain. Thus removal of the superior hypogastric plexus seems to have a firm foundation physiologically.

Before the operation is described and the results in the two groups of patients are given, the type of cases chosen for the operation should necessarily be considered. In our experience (and it is only in cases of dysmenorrhea) it is essential that only those cases with a clear cut history of true primary dysmenorrhea should be considered. If there is any doubt as to the diagnosis, this operation should not be performed. In one of our cases we voiced the suggestion that the patient was not the right type and she has since had no relief of her pain and a subsequent delivery was more painful than ever. This should not be so. Flothow has discovered a test for checking the pain of dysmenorrhea by injection of 2 per cent procaine into the region of the plexus. The second and third lumbar ganglia are injected. He inserts a needle at the level of the fourth lumbar interspace 7 centimeters from the midline at an angle of 45 degrees until the upper portion of the body of the fifth lumbar vertebra is encountered, then advances the needle over the anterolateral surface of the body of the vertebra for a distance of about 1.5 centi-

meters. If this injection is done bilaterally and 5 to 10 cubic centimeters of 2 per cent procaine deposited through each needle, it will result in anesthesia of the superior hypogastric plexus. If this preliminary test could be carried out in all patients with severe dysmenorrhea there ought to be no failure (except for inexpert surgery) and cases not suitable for this type of surgery would be excluded.

THE OPERATION

The operation itself has been reported as both easy and fairly difficult. After doing over 30 I believe that it is not difficult but that it requires considerable patience and painstaking dissection. As it is often said to be combined with the operation of abdominoperineal resection for carcinoma of the rectum by various surgeons it would seem easy to do. I believe that it cannot be satisfactorily done if combined with any long and difficult operation such as abdominoperineal resection for carcinoma of the rectum, for it should take about an hour to do the neurectomy well. Success depends upon the removal of all nerve fibers, even the very small ones; and if they are not entirely removed recurrence of pain may be expected. The operation is done with the patient in Trendelenburg position and the incision is made from about the symphysis to just above the umbilicus. (In women who have had children a midline incision is made but in those with no children a paramedian incision is best.) The pelvic organs are carefully inspected for evidences of pathology, and it is especially important that evidences of endometriosis be sought for, since this entity is so often accompanied by acquired dysmenorrhea. The intestines are well walled off and the posterior peritoneum from the bifurcation of the aorta into the true pelvis is exposed. This peritoneum is picked up with forceps just below the bifurcation and a small incision is made into it. With scissors the loose areolar tissue of the retroperitoneal space is dissected off the under surface of the peritoneum. The opening in the peritoneum is from 10 to 15 centimeters in length. It is well to place three or four silk stay sutures along the edge of the peritoneum to be used as retractors. As the tissue on the right side is

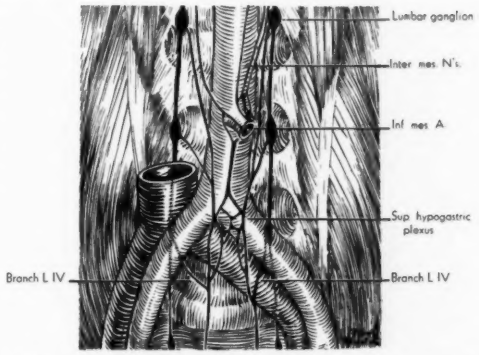

Fig. 1. This drawing shows the origin of the superior hypogastric plexus (presacral nerve) from sympathetic fibers coursing along the aorta arising from the splanchnic, semilunar, and other higher ganglia and from the lumbar ganglia. Notice that the branch from the fourth lumbar ganglion passes under the common iliac arteries and not over the bifurcation of the aorta, as most of the plexus does. This is a very important technical point.

released the right common iliac artery is exposed. Gently with scissors or with small bits of gauze held in hemostats the areolar tissue, connective tissue, and nerves are freed from their connections with the common iliac arteries from the bifurcation of the aorta to the bifurcation of the iliacs. The large left common iliac vein is located directly posterior in the triangle. Great care must be used for a tear in this vein might be disastrous. Occasional small venules arise from it that are easily torn and these should be clamped and tied. The right common iliac vein is not seen as it lies to the outer side of the right common iliac artery. A piece of tape is then threaded under the mass of tissue to be removed and traction made upon it. The dissection is carried up to the bifurcation of the aorta or just above it, and the tissue is clamped and the proximal part is tied. This mass of tissue is then pulled downward and carefully dissected free as far down as the bifurcation of the common iliac arteries on both sides. Here the plexus is clamped and removed and the distal end is tied. The triangle should now be bare from the bifurcation of the aorta to the bifurcation of the common iliacs (Fig. 2). The left iliac vein is clear of all small fibers as is the periosteum and the perichondrium of the fifth lumbar vertebra. The right ureter

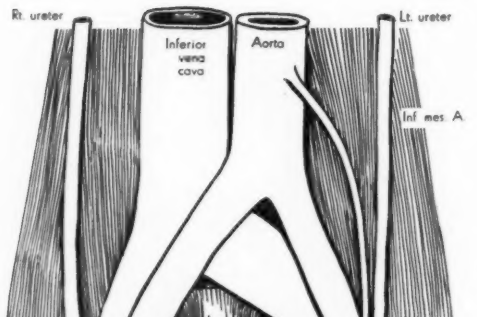

Fig. 2. At the end of the neurectomy the triangle bounded by the bifurcation of the aorta and a line drawn from the bifurcation of one common iliac to the other with the left common iliac vein and the vertebra as the background *must* be cleared of *all* nerve fibers.

has been bared for the whole distance. The left ureter is not always seen in this operation. Care should be taken to make sure that branches from the fourth lumbar ganglia that are found in the triangle under the common iliac arteries are identified and severed (Fig. 1). All suspicious fibers in the triangle should be removed and the area should appear as is shown in Figure 2. No shreds or doubtful pieces of tissue should be left. It is sometimes necessary to tie the middle sacral artery. All ties are of fine silk and the opening in the peritoneum is closed with a continuous suture of silk. Operations for other pelvic pathology should be done either before or after the neurectomy, depending upon which is the more important operation. If the section of the nerve is most important, plenty of time should be allowed for the procedure. It must not be hurried. There is no doubt but that all pelvic pathology should be removed and malpositions should be corrected as a part of the operation. Results from neurectomy alone are not so good as those done combined with necessary pelvic surgery. Occasionally the operation is more difficult due to the position of the left mesocolon; usually it can easily be drawn aside but occasionally it crosses the field of operation in such a fashion as to render approach to the plexus impossible.

RESULTS

Results vary, both in the opinion of the patients and in the opinion of the surgeon (Table I). Patients often forget how much better they are on the whole and base their entire judgment on their feeling at their last period. A later letter or a later interview following a few easy periods discloses a change in the patient's judgment, the particular discomfort is gone and she is well again. Therefore, it seems wiser for the surgeon to present his opinion rather than to have the patient do so. In this series of 20 patients that had a presacral neurectomy without any other pelvic surgery, 15 of them, or 75 per cent, had a successful result. Two patients, or 10 per cent, had a partially successful result. Three cases were complete failures. The percentages of relief are as follows: four, 100 per cent; five, 90 per cent; one, about 80 per cent; four, 70 per cent; two, 50 per cent; one, 30 per cent; and the three others, failures. In 1 failure, Case 2, patient was operated upon in August, 1932. In July, 1933, dilatation was done to attempt relief of the same pain. Up to November, 1936, the relief, according to the patient, was about 90 per cent. Her periods were of shorter duration, one to two days late or early. In January, 1938, cramps started again commencing 2 weeks before the flow began. Examination of the cervix showed that it was open and could be easily dilated, in the Out-Patient Department, up to a No. 16 uterine dilator. A letter from the patient in March, 1938, stated that the cramps were no different than before the operation and that the flow was of shorter duration. Another patient, Case 7, was operated upon in July, 1935, and failure was due, in the author's opinion, to the fact that the cervix was so tight that the menstrual flow could not possibly drain well. Her dysmenorrhea was due to a mechanical block. It was necessary, at a later date, to dilate the cervix. One hour was spent before the finest cervical probe could be passed

through the internal os. Following the operation, dilatation was continued in the office regularly but complete relief was never obtained. However, gradual improvement has occurred so that in April, 1938, the patient can do her daily work and does not remain at home as previously during her period. Nausea was completely relieved by the neurectomy but pain was not. A good deal of her later pain was in the form of backache which was not present before the operation. It is possible that the backache is due to the necessary stretching of the cervix. Incidentally this patient has had much less flow than usual and the period is of shorter duration since her operation. The third patient, Case 16, was operated upon in October, 1936. In January, 1937, she was considerably improved and felt pleased. In June, 1937, she regarded the operation as unsuccessful, with perhaps 10 per cent relief. In March, 1938, she had been having about 40 per cent relief for the past 6 months. She believes that she is now beginning to obtain some relief. She has had no treatment since the operation. This case cannot be regarded as a success.

One of the partial failures should not have had the operation at all as she did not have true dysmenorrhea. Another patient (Case 10), with only a slightly satisfactory result was operated upon in December, 1935. She was judged a questionable candidate for neurectomy before operation. In July, 1936, she stated that the operation was fairly successful giving her about 50 per cent relief. In December, 1936, she reported the operation as partially successful, still with 50 per cent relief. In 1937 she was operated upon again and a uterine suspension was done in another hospital. Following that she had a baby. The birth of the child was very painful and the neurectomy gave her no relief of pain during the delivery. In July, 1938, she reported 30 per cent relief. She has had severe headaches and nausea before her periods for the last year. This patient probably has had relief but will not admit it for she is very disappointed that she was not sterilized and that she has had another child. She is now anxious to be operated upon again; she wishes to be sterilized and hopes her uterus will be removed so she can be sure she will have no more children. This case should not be regarded as a failure, but it is a failure as far as the patient is concerned.

TABLE I.—PRESACRAL NEURECTOMY ALONE

Case Year	Result
1 1930	No pain for 5 years. Recurrence of mild pain. Complete relief again
2 1932	No relief. Dilatation and curettage done in July, 1933. Relief obtained. Pain returned 5½ years after operation
3 1934	Complete relief
4 1934	Complete relief
5 1935	Complete relief. Married. Intercourse satisfactory
6 1935	Complete relief for 1 year, then return of pain 3 years after operation. Relief again obtained. Married. Intercourse not satisfactory
7 1935	No relief. Dilatation and curettage necessary later. Gradual improvement
8 1935	Partial relief for 1 year, then return of pain. Relief again 2 years after operation
9 1935	Complete relief at first. Three years after operation slight amount of pain recurred. Married. Intercourse not satisfactory. One child. Pain slightly less severe than average primipara
10 1935	Fair amount of relief. Two years later suspension done. Intercourse not satisfactory. Child born. More pain than usual with delivery
11 1936	Complete relief
12 1936	Partial relief for a few months. One year later, complete
13 1936	Complete relief. Married. Intercourse not satisfactory. One child. Rhythmic backache. No abdominal pain
14 1936	Complete relief
15 1936	Partial relief
16 1936	Considerable improvement for a few months, then return of pain. Is beginning to obtain some slight relief
17 1936	Complete relief of dyspareunia and dysmenorrhea
18 1937	Complete relief
19 1937	Some relief. Very much better in 1938. Subsequent endometrial biopsy caused no pain
20 1938	Some relief. Getting much better

Postoperative course. The postoperative course in all patients has been entirely satisfactory. None of them had more difficulty than in other abdominal operations. There have been no more postoperative catheterizations and no more difficulty with obtaining bowel movements than in any other abdominal operative procedure.

Postoperative bleeding. In 8, or 40 per cent of the patients, postoperative bleeding was noted directly following the operation. In one it occurred immediately following operation; in one 5 days later; in two, 4 days; in two, 3 days; and in two, 2 days. All patients were a considerable time postmenstrual. One biopsy showed a secretory phase 25 days after the last period, which is normal. In 4, or 29 per cent, there was no postoperative bleeding. In one of these the endometrium was in the proliferative stage at the time of the operation. In 8, or 40 per cent, there was no record as to whether or not there was any postoperative bleeding.

Change in catamenia. Nine patients had a change in their menstrual periods following the operation. One was more frequent; 3 of shorter duration; 2 had less flow; and 3 became irregular. In 9 there was no change; and in 2 the result could not be ascertained.

Urinary changes. In 5 patients there was definite difference in urination. One had less frequency than before. In two a mild cystitis developed due to catheterization. In one urgency persisted 7 years after operation. In one there was change but exactly what could not be determined. In 13 there were absolutely no urinary changes, and in 2 it was not recorded.

Changes in bowel habits. Four patients complained of more constipation than before the operation. In 14 there were no bowel changes. In 2 patients this could not be ascertained.

Previous treatment. Different types of treatment were given the patients before the presacral neurectomy was contemplated. Dilatation was done in 4; dilatation with suspension in 2; a suspension in 1; dilatation, suspension, and oophorectomy in 1 other. Hormones (proluton, progynon, antuitrin S) were given to 5 patients in sufficient amounts without help. In 6, medicines and various other types of treatment had been tried without success. In 2 patients a pessary had been used. These patients were not relieved by their treatment and therefore neurectomy was decided upon. In 5 patients no previous treatment is mentioned in these records. It is our policy not to operate on any patients who have not had previous treatment.

Four patients, or 20 per cent, obtained late partial relief. One had a nervous breakdown 1½ years after operation and another following marriage. Six obtained no relief from their backaches. Inasmuch as the 3 patients who later became pregnant and gave birth to a child had backache, it is evident that backache will not be relieved by presacral neurectomy and that the sensory nerves responsible for backache are different than those causing uterine dysmenorrhea. Four patients, or 20 per cent, had complete relief at first and later, as learned from their letters, had only partial relief. Our first patient had a recurrence 5 years after operation only to have the pain disappear again 6 months later. Five, or 20 per cent, have had a late change in their periods. The change in periods is probably no greater than it is in a normal group of women; nevertheless these facts must be recorded.

Pathology. In every instance the tissue removed showed nerve fibers. It is interesting to note the various findings of the pathology department—small nerve trunks, small sympathetic ganglion, nerve bundles and ganglia, lymph nodes, ganglion cells, clusters of nerve cells like sympathetic ganglion, etc.

Marriage and pregnancy. Five married patients have been interviewed as to whether or not intercourse has been satisfactory. In 4, or 80 per cent, it has not; and in 1, or 20 per cent, it has been. This is important because there may be some interference with the nerve supply of the vagina following this operation. Further accurate figures are necessary to prove this point, as in private practice only about 50 per cent of women have satisfactory intercourse. It is impossible to make a definite statement in regard to this important point. Five patients have married since the operation and 3 have had children. One with only 60 per cent relief from operation had a normal delivery. She and her doctor felt that her pains were slightly less severe than for the average primipara. One patient who had 100 per cent relief from dysmenorrhea had absolutely no abdominal pain of any kind during delivery but did have rhythmic backache. Here again it is evident that backache is not relieved as are uterine cramps by means of resection of the superior hypogastric plexus.

A third patient, Case 10, who has been reported as having an unsatisfactory result states that she had more pain than ever during her delivery. She had only a moderate amount of relief from the presacral neurectomy and from a later suspension of the uterus. This patient has a complex about pregnancy, and it is hard to credit her report about this delivery.

OTHER OPERATIVE PROCEDURES PLUS PRE-SACRAL NEURECTOMY

Seven patients had other operative procedures besides the presacral neurectomy. Of these 6, or 85.7 per cent, report complete relief. This is a very excellent report. One patient was not relieved, but she is so "mothered" by her mother who suffers every pain with her that it is impossible to state whether or not the operation was successful. Letters are received from her regularly every month and about 6 periods a year are painless, and 6 are painful. Her pain when present is said to be worse than it has ever been before. All 6 patients of this group who obtained relief claim it to be 100 per cent. In 3 there was a change in the periods—more regular in 1; slightly shorter duration and smaller in another; and irregular in a third. There was no change in 4. There were no urinary difficulties. Constipation was noted following the operation in one, and another had diarrhea. In 5 there have been no bowel symptoms.

In 6, there was postoperative bleeding. One patient's bleeding started 10 days following the onset of the last period. One went 38 days following the last period and a biopsy at operation showed a proliferative or estrin phase of endometrium. This patient may have had dysmenorrhea without ovulation, a rare occurrence. Two, or 28.6 per cent, of this group had a late change in periods.

Three of the patients had treatment before operation. One had emmenin, aspirin, and viburnum; the second, large doses of progynon; and the third, midol, progynon, and a dilatation. In 4 cases there is no record of the previous treatment. All patients were sent in by their local physicians and doubtless had had medication before coming to the hospital for surgery.

CONCLUSIONS

1. Resection of the superior hypogastric plexus or presacral nerve reduces uterine spasm and vasoconstriction. With these motor fibers there are others that are sensory and carry uterine pain to the central nervous system. Section of this nerve therefore should decrease spasm and permit dilatation of the blood vessels in the pelvis and uterus and should relieve pain sensation. To whatever cause one may attribute pain in dysmenorrhea, it is possible after consideration of the physiology of the nerves to expect relief from the section of them. This it certainly does in a large percentage of cases.

2. It is evident that this operation, which is eminently successful, depends upon proper choice of patients for operation. A patient with uterine dysmenorrhea referred to the region of the anus and coccyx and not into the lumbar or ovarian region, is likely to have relief. A patient with a questionable type of dysmenorrhea, especially the type that might be confused with ovarian dysmenorrhea, should obtain no relief.

3. The operation causes a change in menstrual habits in a considerable number of patients—more than has been reported by other surgeons. These changes are not serious, nevertheless they can be expected and the patient should be so warned.

4. The opinion of the surgeon is a better criterion of relief than the opinion of the patient, because as noted in the long follow-up of these cases, pains and sensations in the pelvis vary and the patient may interpret them incorrectly whereas the surgeon with the entire record at hand can better evaluate the end-result.

5. It is obvious that correction of all pelvic pathology is better than presacral neurectomy alone.

6. Backache is not always relieved. One patient who had complete relief of abdominal cramps still had backache during delivery. Backache apparently is not controlled by the superior hypogastric plexus.

7. Pregnancy is not interfered with inasmuch as out of 5 marriages 3 pregnancies occurred and were successfully terminated. One had absolutely no rhythmic abdominal pain

but did have backache; another had less pain; and a third patient, who was conceded to be a failure as far as the operation was concerned, had no relief.

8. Intercourse may be interfered with since only one of the five married patients had successful orgasm. However, the cases are so few that no definite statement can be made now.

9. Occasionally pain recurs for a short time in spite of complete relief.

10. There are no serious changes in bladder or bowel habits.

11. Finally, it seems obvious that this operation, which appears formidable, is apparently the best form of treatment for patients with true primary dysmenorrhea.

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A CONSIDERATION OF CERTAIN TYPES OF BENIGN TUMORS OF THE PLACENTA

ANDREW A. MARCHETTI, M.D., New York, New York

BENIGN tumors of the placenta are relatively rare. With R. Drummond Maxwell one may readily agree that outside of hospital practice and a university clinic they are seldom if ever seen. Interest centers chiefly about the pathological anatomy and especially the histological structure. The striking variability of the microscopic pattern has been and still is the source of a great deal of confusion in nomenclature. Today these tumors are more commonly known as chorio-angiomas. Though the histogenesis seems to be fairly well established, opinion is still at variance as to whether chorio-angiomas are true tumors or not, while clinically they do not appear to be as important as was formerly thought. It is a collection of 8 such tumors in the pathological laboratory of our clinic that prompts a report and further consideration of the subject, more especially with regard to the interpretation and differentiation of the various types into which these tumors may develop.

HISTORICAL BACKGROUND

The first benign tumor of the placenta found in the literature was reported by John Clarke, in 1798. His description and comment relating to the tumor leave little doubt that it was probably a chorio-angioma although he gave it no designation. The first instance of such a tumor in American literature did not appear until Emil Ries reported his observation in 1904. Virchow, in 1863, designated the tumor as *myxoma fibrosum chorii*, an appellation which frequently has been used by many who have been influenced and have followed this scientific luminary. From about 1880 to the present time it seems that every other additionally reported placental tumor falling into this category has received a new or modified designation, so that an approximation of the number reveals that the same tumor depending upon its type and interpretation has inherited about 30 diverse designations. As far as it has been possible to determine, Beneke in 1900, first employed the term "chorio-angioma." Without enumerating the many others, we favor this term as being the one best suited to the tumor in the light of its histogenesis.

Reports of the occurrence of this tumor tend to show that it is comparatively rare. From earlier studies (Albert, Leopold, Kuehnel) the occurrence was noted once in from 7,000 to 9,000 deliveries. In the New York Lying-In Hospital, following 20,000 successive deliveries, the recognition of chorio-angioma was realized on 6 occasions or approximately a little less than once in 3,500 cases. It should be indicated, however, that 2 factors tend to make its appearance in the literature infrequent. Undoubtedly, there are some that are recognized but remain unreported; and in the second place, and of more importance, there are many which, because of their small size and their position deep in the substance of the placenta, are unrecognized and remain undiagnosed. Siddall lends support to the second circumstance by one of his studies. He hardened, sectioned, and carefully examined 600 placentas. Among them he found 6 instances of chorio-angioma, obviously demonstrating that had the placentas not been subjected to a very minute inspection they would have been discarded as negative.

In surveying the literature Szarthmary, in 1934, collected 238 cases of chorio-angioma, the largest thus far reported. While the list of authors mentioned in the text appears only as references at the end of this paper, it should be pointed out that during the course of this study it was necessary to consult 195 references. Though we are aware that some may

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From the Department of Obstetrics and Gynecology, New York Hospital, Cornell University Medical College.

Fig. 1. Gross specimen from Case 8 showing the chorio-angioma on the fetal surface extending from the margin to the insertion of the cord.

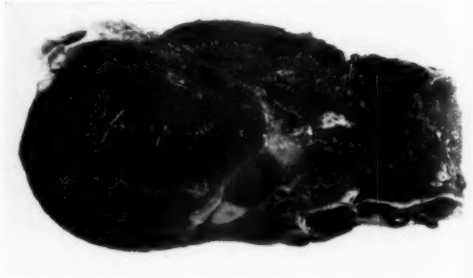

Fig. 2. Cross section of the placenta from Case 4 showing a well circumscribed chorio-angioma of the vascular type. One also sees connective tissue trabeculæ extending through the substances of the tumor.

have been overlooked or entirely missed, we believe that these are almost fully representative of the bibliography on chorio-angioma. In a careful check every care was taken to avoid reduplication of case reports and to exclude those which apparently were incorrectly diagnosed. It was possible then to bring the total number from the literature to 209 instances. The addition of our own 8 cases produces a new total of 217 reported chorio-angiomas.

PATHOLOGICAL ANATOMY

Gross appearance. There is considerable variation in the size of these tumors. They may range from one, the smallest diameter of which measures about 0.5 centimeter, while another may have a diameter of 22 centimeters. The dimensions of the average sized chorio-angioma will vary from about 2 by 3 by 3.5 centimeters to about 4 by 5.5 by 8 centimeters. Generally the tumor is solitary, but multiple ones have been described. The shape is usually round to oval, and may be nodular or lobulated, while the surface is usually smooth. The tumor is always invested by a capsule or, as some interpret it, a pseudocapsule and may be readily enucleated from the adjoining placental tissue.

Ordinarily the fetal surface is the site of predilection, however, many are located on the margins and others are found buried in the substance of the placenta. Some are found protruding from the maternal surface and a very few have been noted at the base of the umbilical cord entirely separated from the placenta proper.

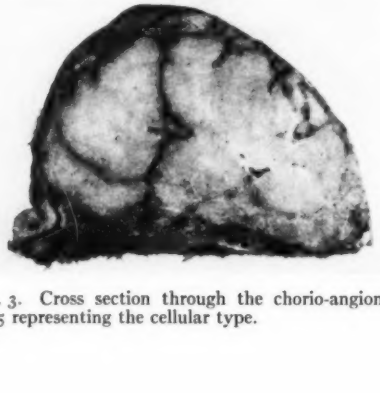

Fig. 3. Cross section through the chorio-angioma of Case 5 representing the cellular type.

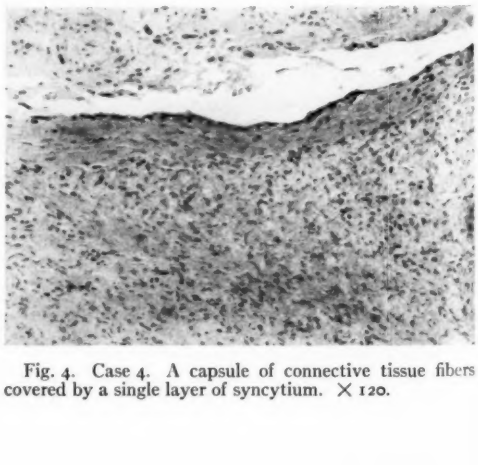

Fig. 4. Case 4. A capsule of connective tissue fibers covered by a single layer of syncytium. × 120.

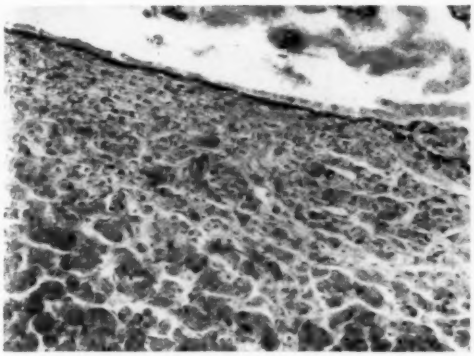

Fig. 5. Case 2. Illustration of a capsule consisting of a few if any connective tissue fibers and a single layer of syncytium-like epithelium. × 120.

The color of the predominantly vascular tumor is a deep bluish-red, whereas that of the more cellular type is a grayish-red. On bisection, the cut surface simulates the appearance of the liver, spleen, or renal cortex, and may show a single or multilobular structure whose units are divided by fibrous connective tissue trabeculæ. Often the combination and variation of the 2 types give the surface a mottled appearance.

The consistency of the tumor is uniformly firm approaching in many instances that of a fibroma. The vascular connection of the chorio-angioma with chorionic blood vessels or directly with those of the umbilical cord is established by the larger vessels of the tumor. Occasionally the communication between the tumor and the blood vessels of the umbilical cord is represented by a well defined vascular pedicle.

Microscopic appearance. The great variety of microscopic pictures is such that it has caused a striking confusion in nomenclature. This is due to the variability in position, amount, condition, and degree of development of the blood vessels, and connective tissue elements which make up the various histological patterns seen in different chorio-angiomas or even in the same tumor.

All chorio-angiomas are well circumscribed. Some are encapsulated by a thin or thick layer of connective tissue fibers covered usually by a single layer of syncytium (Fig. 4); others are

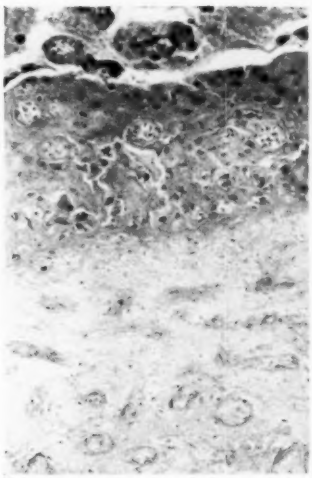

Fig. 6. Case 3. Illustration of the so called pseudocapsule enveloping a chorio-angioma of the degenerated type. × 120.

simply invested by a single layer of syncytium-like epithelium (Fig. 5). The tumors which are not as well preserved or show different degrees of degeneration are bordered by a comparatively thick, partly hyalinized, fibrinoid tissue in which swollen, vacuolated, and degenerating chorionic epithelium is enmeshed (Fig. 6). This is the pseudocapsule referred to by many writers. In reality it is formed by the agglutination of the degenerated epithelium of the adjoining and surrounding compressed chorionic villi to the surface of the tumor, the syncytial epithelial covering of which has in great part disappeared. Whether by their capsule or pseudocapsule, chorio-angiomas are always sharply demarcated from the surrounding placental tissue.

The most common type of chorio-angioma is characterized by the following components: a more or less loose groundwork of chorionic stromal cells, predominantly ovoid in shape, supports numerous small blood vessels and capillaries. These vessels, for the most part, are dilated and filled with blood cells and are generally lined with a single layer of endothelium (Figs. 7 and 8). They are uniformly or diffusely distributed throughout the tumor, or arranged in clusters, or again may be conflu-

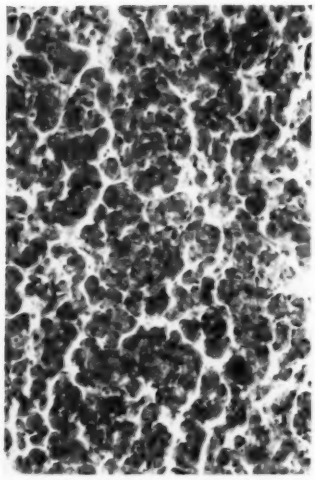

Fig. 7. Case 2. A typical area of the mature or vascular type of chorio-angioma with practically all capillaries and blood vessels dilated and filled with red blood cells. × 120.

ent so that a somewhat cavernous structure results. Fibrous connective tissue trabeculæ carrying blood vessels of varying caliber are seen working their way through the substance of the tumor dividing it into lobules of diverse sizes. This description applies particularly to the predominantly vascular or the more mature type.

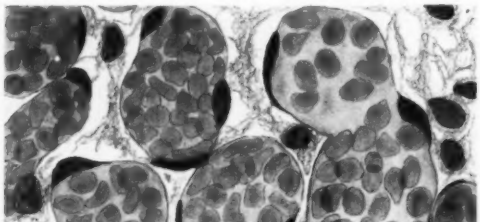

Fig. 8. A camera lucida drawing from a small area in Figure 7 illustrating the capillaries dilated with red blood cells and lined by a single layer of endothelium. One also notes the loose connective tissue ground work and stromal cells. × 750.

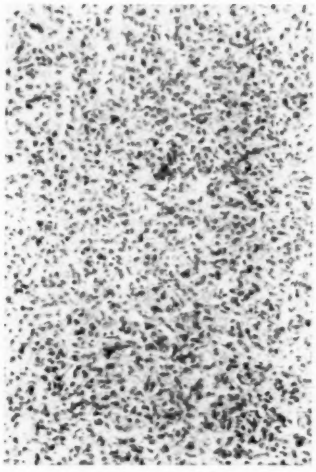

Fig. 9. Case 5. A typical area of the cellular or immature type of chorio-angioma. This is the type that has the fibromatous or sarcomatous appearance. × 120.

A less common type is that which is composed of more cellular elements. Such tumors consist of an abundance of endothelial and chorionic stromal cells many of which are quite embryonal in character. The structure at once impresses one as being very compact. Closer scrutiny will disclose that many of the endothelial cells are lining interstices and small blood vessels which are obviously collapsed (Figs. 9, 10, and 11). Transition from these compact cellular areas to small isolated angiomatous areas with dilated capillaries filled with blood cells is noted (Fig. 12). This profusion of embryonal mesenchymal cells, differentiated into young chorionic stromal cells and endothelium with occasional mitotic activity, represents the more immature type of chorio-angioma. Beaufays has recently described and designated such a tumor as a mesenchymal angioma of the placenta. Between these 2 characteristic extremes it is obviously possible to obtain many combinations of the vascular and cellular constituents.

A third type is distinguished by various degrees of degeneration, a process which is naturally expected to be secondary to any primary growth. Interstitial edema, swelling and vacuolization of stromal cells, degeneration, and disappearance of the endothelial lining of the

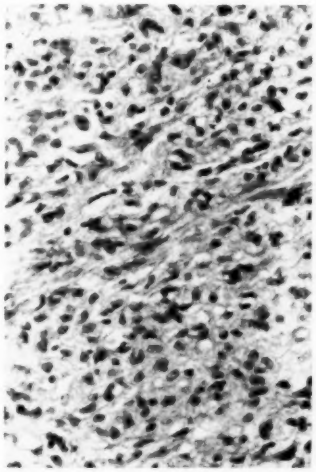

Fig. 10. A higher power from Case 5 showing the embryonal character of the cells. × 235.

blood vessels and epithelial lining of the tumor, reduction in number, or absence of blood cells in the capillaries may give certain areas or the greater part of the tumor an areolar or myxomatous appearance (Fig. 13). In addition, these may be accompanied by calcareous, fibrinoid, or hyaline changes.

In any of these 3 types we have failed to appreciate a sufficient preponderance of fibrous connective tissue such as would justify an adherence to the designation of fibroma in connection with these chorio-angiomatous tumors. A consideration of the histogenesis will tend to support this exclusion.

HISTOGENESIS

The resemblance of the components of chorio-angioma to the blood vessels and stroma of the normally developing chorionic villus unquestionably points to their origin from the chorionic mesenchyme, the common source of endothelial and connective tissue. That there is a close embryogenetic relationship between endothelium, connective tissue, and blood cells is fairly well established. One is able to note in the cellular or more immature type of chorio-angioma the process of transition from the embryonal type of mesenchymal cells into more adult types of endothelial and stromal cells.

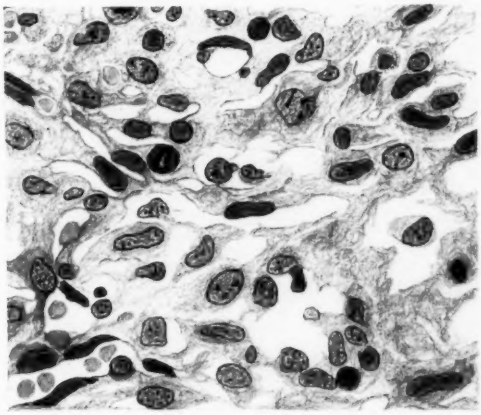

Fig. 11. A camera lucida drawing from an area in specimen from Case 5 illustrating collapsed capillaries and interstices lined with endothelial cells. The greater part of the cells, both endothelial and stromal, have a more immature appearance. One sees an endothelial cell in mitotic division. × 750.

The proliferating endothelium assumes at once the predominant rôle. Ultimately the development and growth progresses to complete angioma formation with the stroma playing only a subordinate or accessory rôle. Beaufays describes and discusses this succession of developments very well in his report of

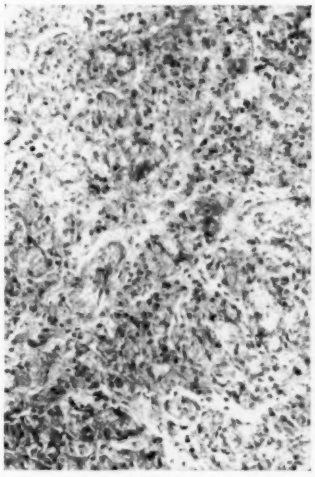

Fig. 12. Case 4. An area illustrating transition from the cellular to the vascular type. × 120.

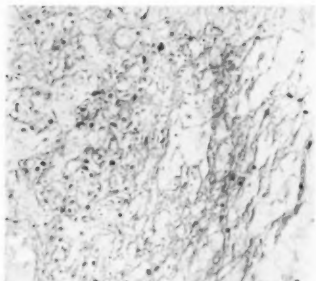

Fig. 13.

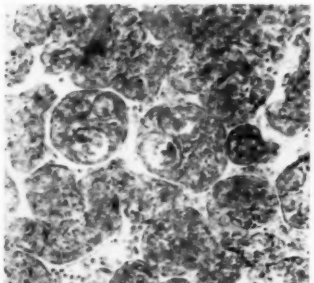

Fig. 14.

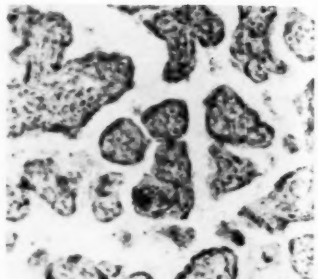

Fig. 15.

Fig. 13. Case 6. The degenerated type of chorio-angioma having an areolar and myxomatous appearance. × 120.

Fig. 14. An area from a placenta illustrating the condition designated as angiectasis of the chorionic villi, but often mistaken for chorio-angioma. × 120.

Fig. 15. An area of a normal placenta inserted for contrast and comparison. × 240.

the mesenchymal angioma. In the same paper he quotes Klinge's conception of the histogenesis of angiomas to give support to his argument. However, as he concludes that the mesenchymal angioma is a different tumor from the simple placental angioma because it has a different origin, we must beg to arrive at a different conclusion. By simple placental angioma we interpret him as meaning chorio-angioma. If our interpretation is correct, the tumor he describes has the same origin as the chorio-angioma and we consider it merely a manifestation of the immature, cellular type.

The hypothesis that chorio-angiomas may represent phases in the development of the hydatidiform mole or chorio-epithelioma as pointed out by Virchow, Valeri, and Storch, is now considered wholly untenable. The mole and chorio-epithelioma are tumors of epithelial origin and pre-eminently associated with malignancy, 2 characteristics which contrast decidedly and, unquestionably, exclude any relationship to chorio-angioma.

ORIGIN

It is desirable to introduce the subject of the origin of chorio-angioma with a brief discussion of whether an angioma is a true tumor or not. Indeed, this is a controversial point among pathologists which still remains unsettled. There are 2 prevailing points of view: The first, and one which seems to be accepted generally, is Ribbert's idea that it is an independent growth originating from a rudiment predetermined to form blood vessels. The second is the conception championed by Albrecht and supported prominently by R. Meyer, that angiomas are the result of fetal displacement or malformation of tissue. Albrecht differentiates these displacements and perverted formations as *hamartomas*, and when they assume the form of a tumor R. Meyer distinguishes them as *hamartoblastomas*. Hinselmann enjoys a little play in antithesis when he calls chorio-angioma the antipode of hydatidiform mole. The former is a malformation caused by an excess of development or *Excessmissbildung*, whereas the latter is a malformation resulting from arrest of development or *Hemmungsmissbildung*.

The unchallenged conception and definition of a tumor is still to be sought and further discussion of this subject is left to the investigator with more profound philosophic and aca-

demic inclinations. With the knowledge and criteria at present available we are of the opinion that one cannot say with any finality that benign tumors of the placenta are true tumors even though the greater number of writers are inclined to believe that they are.

It is unnecessary to go into the details of some of the older theories which were advanced to explain the origin of chorio-angiomas. Most of them are now considered untenable. However, some mention of these theories does appear essential for the sake of completeness. Danyau and Goodhart speculated that their origin could be traced to organized blood clots. Albert and Dienst supported the idea that these tumors originated from vessels derived from the allantois. Many others considered an inflammatory basis as their source (Plauchu and Savy, von Mars, Lonnberg, Berglund, Le Page, Solowij). Chorio-angioma, the result of degeneration and necrosis, was advanced by Grafenberg and Hildebrand. Storch, Merttens, and Gueniot proposed that they originated as a result of hyperplasia of the chorionic villi. Finally among the many authors linking their origin to aberrations or disturbances of the maternal and fetal circulation such as stasis, increased tension, obstruction, hyperemia singly or in combinations, are Dienst, van der Feltz, Johnstone, Schindler, J. P. Maxwell, McDonald and Burnett, and Pitha.

Today the origin and formation of chorio-angiomas are explained in the following generally accepted manner: A group of blood vessels and stroma are thought to take on active proliferation and growth outside of the regular arrangement and restriction of the normally developing chorionic villi. Without the guidance of the chorionic epithelium covering the villi, the tumor forms in the chorionic surface plate or in some cases in the large trunk villi and develops independently of the normally developed surrounding tissue. Thus the tumor with its capsule is somewhat isolated and does not bear a physiological relation to the functioning portions of the placenta. Its growth is not limited.

Whether the anlage is congenital or whether it is a faulty tissue mixture depends upon whether one believes with Ribbert that it is a true tumor, or with Albrecht and R. Meyer that it is a malformation or *hamartoma*.

TYPES

Fuller consideration of the histological structure of chorio-angioma, as described under the pathological anatomy, reveals that the tumor may be differentiated into various types. However, such a differentiation does not carry the implication that these forms may be classified as different tumors. They represent various phases of development in different or in the same chorio-angioma. Furthermore, this attitude lends understanding to the discussion of tumors which at first were misunderstood and were ultimately proven to be chorio-angiomas as well as to other conditions which have been incorrectly diagnosed as this tumor.

In the first place we should consider the cellular, more immature, or less differentiated type. Again may we refer to Beaufays' *angioma mesenchymale* of the placenta which we believe is a chorio-angioma with less differentiated manifestations of the more adult tumor and consequently of the same origin. This cellular type is the one that has been frequently and incorrectly designated in the past as sarcoma, fibrosarcoma, and angiosarcoma of the placenta. As yet a chorio-angioma with proven malignant changes remains to be reported. Cary's case of sarcoma of the placenta, examined and thought to be sarcoma by J. W. Williams and Welch, was later reconsidered by Williams and shown to be a chorio-angioma. However, malignant metastases to the placenta have been described on 3 occasions (the cases of Walz, Senge, and Markus). Lacassagne and Vignes have pointed out that the degree of proliferation of the endothelium makes one think of endothelioma. Frayman and Gorjajewa in 1928 reported a case of endothelioma placentæ. The illustrations of this tumor convince us that in all likelihood it is a chorio-angioma of the cellular type. Because of its occasionally compact structure, this type has also been incorrectly diagnosed as fibroma of the placenta (Auvard, Kramer). On the other hand, there have been tumors designated as fibroma of the placenta which were later thought to be, and in one or two instances proved to be, submucous myoma of the uterus

(Harper, Hodgen, Loebl). It is quite conceivable that a submucous myoma can be overlapped by a placenta and form vascular connections with it. At the completion of delivery the myoma may detach itself with the placenta or it may be removed manually because of postpartum hemorrhage, an experience which we have already encountered in this clinic. Gheorghiu's and Hojnacki's cases also, were probable instances of submucous myomas and not placental fibromas.

The full grown angiomatous tumor should in our opinion be regarded as the vascular or mature chorio-angioma. This is the type that has been least mistaken even though it has had its share of diverse designations. At this point, it would be well to discuss and direct attention to a condition which may be commonly seen in placental villi. This is not a tumor formation but has been incorrectly diagnosed chorio-angioma. Occasionally in the intraplacental substance one finds circumscribed or diffuse areas of agglutinated villi. These fused villi show some edema of the stroma, partial or total loss of their surface epithelium, and above all dilatation of the individual blood vessels (Fig. 14). G. Mueller classifies it as a pseudo-angiomatous structure and in our opinion correctly designates it as angiectasis of the chorionic villi. Meyenburg prefers to speak of it as *hæmangiomatosis diffusa placentæ* or simply, angiomatosis of the placenta. Schickele terms it an intraplacental angioma resulting from blood vessel proliferation in an already formed villus. The cases reported by Moller and Lohse, Gueniot, and Brugger are examples of angiectasis.

Finally, there is the type showing various degrees of degenerative changes. This form with its vacuolated, areola-like, edematous areas has been frequently interpreted as myxomatous. Oskar Frankl objects to the affixation, myxomatosum, and states that this term is incorrect inasmuch as mucus cells do not come into the consideration.

It is obvious that these characteristic types develop in the same or in different chorio-angiomas, but we wish to emphasize and are quite confident that they represent various phases of development in the same tumor process.

CLINICAL ASPECTS

From the purely clinical point of view it is apparent that chorio-angioma has been given more significance in relation to the welfare of the mother and fetus than it merits.

It is important to point out that it is always a benign tumor. Authors, in particular Boehi, who have emphasized the sarcomatous histological characteristics of the cellular type have in turn indicated the benign nature of the tumor as borne out by the course and follow-up of their patients. No relationship has been definitely established between any disease complicating pregnancy and chorio-angioma.

The frequent association of hydramnios with this tumor is being recognized as more accidental than actual. Formerly more emphasis was placed upon chorio-angioma and hydramnios with its consequent morbid relationship to the fetus, prematurity, stillbirth, malformations, etc. Theuveney intimates that this correlation is purely co-incidental. Schickele discussing Thomas' case in 1925 could not definitely link the 2 conditions. More recently Kuehnel in his critical, statistical study, although leaving the question open, tended to present evidence in favor of it being co-incidental. However, Szarthmary reports a hydramnios incidence of 31 per cent in his review of the literature, a figure which is impressively high and would seem to connote an interrelationship between the tumors and excessive amniotic fluid.

One complication, though rare, which may arise is the possibility of a large chorio-angioma being so situated that it may cause an obstruction to the normal birth of the fetus. Emge and Margeson have each reported a case in which cesarean section was performed for dystocia, later finding that the circumstance mentioned above was the provocative cause.

Chorio-angiomas have been considered to have a deleterious effect upon the fetus. From the studies of Siddall, Kuehnel and others, closer evaluation of their statistics seem to indicate that the high incidences of prematurity, stillbirths, and premature rupture of the membranes are attributable to other more significant causes and complications. In our small series of 8 cases the welfare of the mother

or fetus was certainly not affected by the presence of a chorio-angioma. Among them, it is true, there was an infant considered premature, but she was born of a mother with a toxemia of pregnancy, a complication that is known to affect the size of a baby in many instances. In these cases also, hydramnios and premature rupture of the membranes were not noted in a single instance. With the possible exception of hydramnios and the extremely rare possibility of dystocia, it may be concluded from the evidence we have at hand that chorio-angioma is clinically insignificant.

CASE REPORTS

Six of the following 8 cases were collected during the last 5 years; the 2 others were found in the older material preserved in our pathological museum:

CASE 1. B. R., (Berwind No. 32551, P-223), white, secundipara, age 22. The last menstrual period occurred on March 2, 1932; expected date of confinement was December 9, 1932. There was a normal antenatal course, and a spontaneous delivery without a history of premature rupture of the membranes of a normal, female, living infant weighing 4,060 grams on December 3, 1932. Duration of labor was 3 hours and 10 minutes; blood loss 150 cubic centimeters; puerperium was normal.

Placenta. The placenta weighed 775 grams and was 2 by 16 by 17 centimeters in size. On the maternal surface and extending into the substance of the placenta, a fibrous, well circumscribed nodule measuring 2.5 by 4 by 4 centimeters was found. The tumor was readily enucleated from its bed and on bisection the cut surface was grayish-red in color. Microscopic examination revealed a well encapsulated chorio-angioma of the cellular variety. For the most part the texture of the tumor appeared compact. Here and there, along the periphery especially, one saw isolated angiomatous areas. The denser areas, which made up the greater part of the tumor, conformed to the immature type of tumor described in the text, that is, collapsed capillaries and interstices lined with endothelial cells supported in a network of connective tissue and stromal cells of a more embryonal character. Occasionally a cell was observed in mitotic division.

CASE 2. E. S., (No. 22433, P-510), white, nullipara, age 30. The patient's last menstrual period occurred on August 15, 1932; expected date of confinement was May 22, 1933. There was a normal antenatal course with no history of premature rupture of the membranes. Spontaneous delivery of a normal, female, living infant weighing 2,850 grams, June 2, 1933. Duration of labor, 7 hours 9 minutes; blood loss, 300 cubic centimeters; puerperium, normal.

Placenta. The placenta weighed 720 grams; the dimensions were 4 by 8 by 10 centimeters. A small, firm, rounded tumor measuring 3 centimeters in diameter was found just beneath the amnion on the fetal surface halfway between the centrally inserted umbilical cord and the margin of the placenta. Microscopic study showed that it was a well preserved chorio-angioma of the vascular type. Uniformly it consisted of dilated capillaries filled with red blood cells. The stroma was composed of ovoid cells which were found scattered in small numbers in the connective tissue spaces between the capillaries. Inasmuch as compact cellular areas or degenerated ones were entirely absent in this tumor, it can be considered an example of the mature variety of chorio-angioma.

CASE 3. M. T., (No. 44808, P-738), white, quintipara, age 30. The patient had her last menstrual period on February 1, 1933; expected date of confinement was November 8, 1933. The antenatal course was complicated by hypertension and chronic nephritis. On November 8, 1933, spontaneous delivery occurred of a normal, female, living infant weighing 3,300 grams. Duration of labor was 1 hour and 50 minutes; blood loss was 200 cubic centimeters. The patient was discharged in good condition.

Placenta. The weight of the placenta was 420 grams, the dimensions, 2 by 15.5 by 17 centimeters. Buried in the substance of the placenta, at the time that it was examined and sectioned, a small firm nodule 1.5 by 2.5 centimeters was found. The small tumor was readily enucleated from the surrounding placental tissue and its consistency was noted to be just a little firmer than the placenta itself. Microscopic examination disclosed that it was a chorio-angioma of the degenerated type. In general one finds vacuolated areas resembling areolar or myxomatous tissue. The capillaries have lost their endothelial lining, wholly or in part, and for the most part the red blood cells have disappeared from the lumina of the vessels. Here and there one does find areas in a better state of preservation making its recognition as a chorio-angioma unmistakable.

CASE 4. E. R., (No. 107080, P-1695), white, nullipara, age 24. The last menstrual period occurred on December 28, 1934; expected date of confinement was October 5, 1935. Antenatal course was normal. On September 26, 1935, there was a low forceps delivery, because of a prolonged second stage, of a normal, male, living infant weighing 3,220 grams. Duration of labor was 9 hours and 6 minutes; blood loss 400 cubic centimeters; puerperium was normal.

Placenta. The weight of the placenta was 850 grams, the dimensions 2 by 19 by 19 centimeters. A tumor 5 by 6 by 6 centimeters was found on the margin of the fetal surface. Microscopic study showed that it was a chorio-angioma of the vascular variety. This one is not found as entirely typical as the tumor described in Case 2. There are a few regions showing transition from the cellular structure to the angiomatous one. However, considered as a whole the pattern conformed to the more mature or vascular chorio-angioma.

CASE 5. J. C., (Berwind No. 40891, P-2956), white, septipara, age 32. The patient's last menstrual period took place on March 6, 1937; expected date of confinement was December 13, 1937. The antenatal course was normal. Spontaneous delivery of a normal, female, living infant weighing 3,500 grams occurred on December 10, 1937. There was no history of a premature rupture of the membranes. Duration of labor was 3 hours and 42 minutes; blood loss 175 cubic centimeters, and the puerperium was normal.

Placenta. The weight of the placenta was 700 grams, the dimensions 3 by 23 by 28 centimeters. Protruding from the margin of the maternal surface was a tumor measuring 3 by 3 by 4 centimeters. Microscopic examination revealed that the tumor was a chorio-angioma of the cellular variety. The histological picture was similar to the one described in Case 1 except that there were fewer angiomatous changes in Case 5.

CASE 6. A. S., (No. 194682, P-3125), white, primipara, age 37. The last menstrual period occurred on July 11, 1937; expected date of confinement was April 18, 1938. The antenatal course was complicated by a toxemia, chronic nephritis. The membranes ruptured at the onset of labor, and there was a low forceps delivery of a normal, premature, female, living infant weighing 2,230 grams and whose length measured 40 centimeters. Delivery occurred on March 29, 1938. Duration of labor was 5 hours and 47 minutes; blood loss 80 cubic centimeters. The patient was discharged in good condition as was also the baby.

Placenta. The placenta weighed 600 grams and measured 3 by 16 by 18 centimeters. About 4 centimeters away from the insertion of the cord on the fetal surface just beneath the amnion, a small tumor 1 by 2 centimeters was enucleated. Microscopic study demonstrated a chorio-angioma of the degenerated type. This tumor was not unlike the one described in Case 3.

CASE 7. E. H., (No. 82873, P-3093), white, primipara, age 34. The last menstrual period was on January 4, 1930; expected date of confinement was October 11, 1930. The antenatal course was complicated by an unclassified toxemia. On October 9, 1930, a mid-forceps delivery of a normal, female, living infant weighing 2,400 grams and 50 centimeters long was performed. Duration of labor was 65 hours and 30 minutes without a history of premature rupture of the membranes; blood loss 400 cubic centimeters; puerperium was normal.

Placenta. The weight of the placenta was 540 grams, the dimensions, 1.7 by 17 by 19 centimeters. Close to the insertion of the cord on the fetal surface a tumor was found measuring 2 by 3 by 3 centimeters. Microscopic examination showed that it was a chorio-angioma of the immature type. It conformed in structure and pattern to the cellular variety described in the text.

CASE 8. (P-3094). The clinical history of this patient could not be found. However, the specimen was preserved in our museum and a photograph of it is reproduced in the text (Fig. 1). In its fixed condition, the placenta weighed 700 grams and measured 4.5 by 8 by 10 centimeters. Microscopic study disclosed that it was a chorio-angioma of the vascular type.

SUMMARY

1. Benign tumors of the placenta designated as chorio-angiomas are relatively rare.

2. On the basis of their histological structure and pattern these tumors are differentiated into several types. The cellular or immature, the vascular or more mature type, and that type accompanied by varying degrees of degenerative changes are presented. These forms may intermingle in all gradations in the same tumor.

3. The histogenesis of these tumors is fairly well established. The tissue originates from the chorionic mesenchyme, the proliferating endothelium and blood vessels playing the leading rôle, the stroma a subordinate or accessory rôle.

4. Whether the neoplasm is a true tumor according to Ribbert's idea or a malformation as explained by R. Meyer is still an open question.

5. The older, discarded theories of the origin of the tumors and that which has been accepted are discussed.

6. Clinically it is believed that chorio-angiomas are of little significance.

7. Two hundred and nine cases are collected from the literature, to which are added 8 of our own, bringing the total number to 217.

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BLOOD IODINE LEVELS RELATED TO THE RECURRENCE OF HYPERTHYROIDISM

H. J. PERKIN, M.A., and RICHARD B. CATTELL, M.D., F.A.C.S.,
Boston, Massachusetts

A BETTER understanding of the metabolism of iodine in patients with goiter has been realized by the quantitative analysis of iodine in the blood. Many investigators (1, 2, 3, 4, 11) have repeatedly demonstrated the presence of abnormal blood iodine levels in cases of hyperthyroidism. In previous reports, we have shown that the estimation of the pre-operative level of blood iodine has been an aid not only in establishing the clinical diagnosis (5) but also in evaluating the severity of the disease (6). Two reports (1, 9), dealing with the blood iodine level at intervals after operation, have appeared in the literature. In this connection our previous work (9) indicated that, following subtotal thyroidectomy, estimations of the level of iodine in the blood taken at stated intervals have given us a means whereby cases can be predicted which are predisposed to recurrence or persistence of clinical hyperthyroidism. The present report consists of further observations on the level of iodine in the blood before and after subtotal thyroidectomy for hyperthyroidism. Furthermore, we wish to present additional evidence from the present results, which permits a selection of patients in whom recurrence is likely to follow subtotal thyroidectomy. It is our belief that more radical operations in these cases will result in a lower incidence of recurrent hyperthyroidism.

The study is based on 256 cases of exophthalmic goiter with 833 blood iodine values of these patients. This comprises an additional group to those previously reported (9). In so far as could be determined, none of the patients had received any treatment for their hyperthyroidism prior to coming under observation at The Lahey Clinic. The blood iodine level was determined in each case before beginning the administration of Lugol's solution (7, 8). All the patients were examined at intervals following operation, at which time the amount of iodine in the blood was again estimated. Of the 256 patients, 100 returned at intervals during 1 year for these check-up examinations. During the course of this study, while observing these 256 patients, approximately 750 additional cases were studied by the same methods and criteria. This larger group was excluded from the present report because of positive or presumptive evidence, from either the patient or referring physician, that iodine medication had been received prior to coming under our observation. It is probable that a few of these cases not included in this report should not have been excluded.

In a previous report (9), the findings showed that patients with hyperthyroidism with a pre-operative elevation in blood iodine have normal levels following subtotal thyroidectomy (designated as Group I below). On the other hand we found that individuals with signs and symptoms of hyperthyroidism in the presence of a normal blood iodine, had a relative increase in the blood iodine level after operation (Group II). The additional findings to be presented in this paper confirmed the above observations. In addition a group of cases has been encountered in which the pre-operative blood iodine value was found to be normal with no change in this level following subtotal thyroidectomy (designated as Group III). Since all of our cases with hyperthyroidism studied fall into one of the above groups, we have divided them into the 3 groups mentioned, Groups I, II and III.

Group I. Of 170 patients with hyperthyroidism with an elevated pre-operative blood iodine level, who were examined after operation at regular intervals, 59 were followed for 1 year. Since the results of the group as a whole were relatively consistent, it is considered fair to average the blood iodine values at

From the Research Foundation and Department of Surgery of The Lahey Clinic.

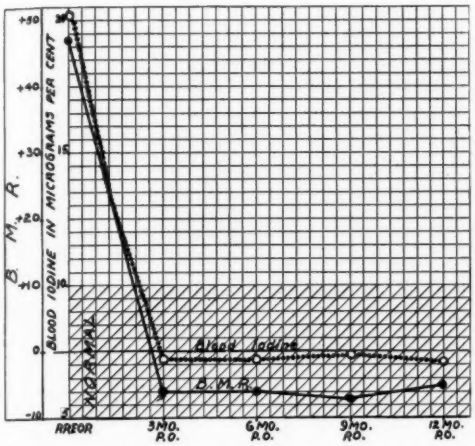

Fig. 1. The relation of the blood iodine level to the basal metabolic rate before and after subtotal thyroidectomy in cases of Group I.

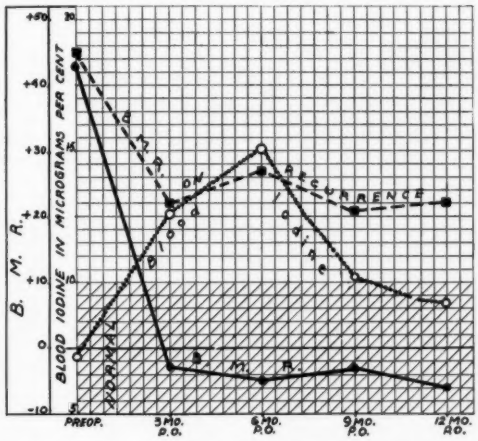

Fig. 2. The relation of the blood iodine level to the basal metabolic rate before and after subtotal thyroidectomy in cases of Group II.

the pre-operative and at each postoperative period. The average of the basal metabolic tests on these patients has been included. The findings are shown in Table I. From Table I it will be seen that the blood iodine level paralleled the basal metabolic rate in that the preoperative elevation in both instances fell to normal values following subtotal thyroidectomy, as shown graphically in Figure 1.

The clinical records of the cases of Group I were noteworthy. Of the 170 cases followed, 154 patients (90.6 per cent) were completely relieved, 15 patients (8.8 per cent) showed transitory postoperative myxedema, 1 patient (0.6 per cent) had recurrent hyperthyroidism.

Group II. Of 61 cases with a normal preoperative and a postoperative increase in blood iodine, 28 were followed for 1 year. In the majority of instances, the maximal elevation in the level of iodine in the blood occurred at the sixth month following operation. The average blood iodine values together with the average basal metabolic rates are shown in Table II. From Table II, it will be seen that no apparent relationship existed between the blood iodine level and the basal metabolic rate. The results are shown graphically in Figure 2.

Analysis of the clinical histories of the cases of Group II revealed that of the 61 patients followed, 45 (73.7 per cent) were clinically cured, 2 (3.3 per cent) had transitory postoperative myxedema, 12 (19.7 per cent) had persistence or recurrence, and 2 (3.3 per cent) had malignant exophthalmos without symptoms of hyperthyroidism.

The high incidence of recurrent hyperthyroidism in patients with a normal or low preoperative level of iodine in the blood con-

TABLE I.—THE PRE-OPERATIVE AND POST-OPERATIVE FINDINGS IN GROUP I

	Cases	Average B.M.R.	Average blood iodine in μgm.*%
Pre-operative	170	+47	20.1
Postoperative			
3 mos.	123	—6	6.9
6 mos.	118	—6	6.7
9 mos.	56	—7	7.2
1 yr.	59	—5	6.8

*μgm.—microgram.

TABLE II.—THE PRE-OPERATIVE AND POST-OPERATIVE FINDINGS IN GROUP II

		Average B.M.R.		
	Cases	Patients (12) with recurrence	Patients cured	Average blood iodine in μgm.%
Pre-operative	61	+45	+43	7.1
Postoperative				
3 mos.	51	+22	—3	13.1
6 mos.	45	+27	—5	15.6
9 mos.	31	+21	—3	10.4
1 yr.	28	+22	—6	8.2

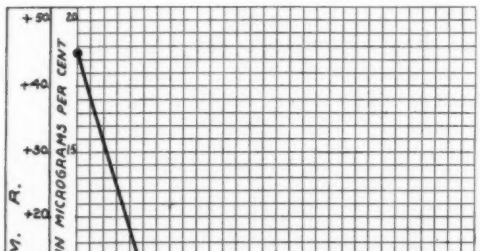

Fig. 3. The relation of the blood iodine level to the basal metabolic rate before and after subtotal thyroidectomy in cases of Group III.

firmed our former observations (9). Furthermore, there was a consistent increase in the blood iodine after operation in these patients with recurrence of symptoms (Table II). In this group of cases (Group II) myxedema following subtotal thyroidectomy was rare (3.3 per cent). These findings in our opinion justify a more radical thyroidectomy in patients with a normal or low pre-operative blood iodine; in other words, relatively smaller thyroid remnants should be left than when the pre-operative blood iodine level is elevated.

Group III. There were 25 patients in the group with hyperthyroidism who had a normal blood iodine level before operation and no change in level following subtotal thyroidectomy. Thirteen of these individuals were followed for 1 year. The results of this group are shown in Table III. Table III shows that, as in the cases of Group II, there was no obvious relationship between the basal metabolic rate and the level of iodine in the blood. The results are illustrated graphically in Figure 3. Clinical data of the cases of Group III revealed that of the 25 cases followed 24 patients (96 per cent) were clinically cured and 1 patient (4 per cent) had transitory postoperative myxedema. The hyperthyroid cases of Group III appeared to have the most favorable clinical course following subtotal thyroidectomy of the 3 groups.

Recent studies (10) concerning the relationship between the blood iodine level and the duration of symptoms in individuals with exophthalmic goiter have shown that the blood iodine is usually elevated when the hyperthyroid symptoms have been present for less than 9 months. On the other hand, patients exhibiting untreated symptoms of hyperthyroidism for 1 year or longer usually have blood iodine values within the range of normal. This observation may be correlated with the results of the present study. With the duration of symptoms heretofore established (10), the number of cases in Groups I, II, and III was charted against the duration of symptoms prior to treatment for each case respectively (Table IV).

As will be seen from Table IV: (a) The incidence of hyperthyroid cases with an elevated pre-operative and a postoperative fall in blood iodine (cases of Group I) decreased as the duration of symptoms for the cases increased. (b) The incidence of hyperthyroid cases with a normal pre-operative and a postoperative increase in blood iodine (cases of Group II) increased with a corresponding increase in the duration of symptoms, the greater percentage of such cases occurring at the duration period of 10 to 12 months. (c) The incidence of hyperthyroid cases with a normal pre-operative blood iodine and no change in blood iodine following subtotal thyroidectomy increased (cases of Group III) from 10 to 12 months, with an

TABLE III.—THE PRE-OPERATIVE AND POST-OPERATIVE FINDINGS IN GROUP III

	Cases	Average B.M.R.	Average blood iodine in μgm. per cent
Pre-operative	25	+45	6.6
Postoperative			
3 mos.	19	−2	6.8
6 mos.	23	−1	7.3
9 mos.	11	−3	6.7
1 yr.	13	−5	6.4

TABLE IV.—DURATION OF SYMPTOMS

	Group I		Group II		Group III	
	Cases	Per cent	Cases	Per cent	Cases	Per cent
1 to 3 mos.	55	100	0	0	0	0
4 to 6 mos.	50	94	3	6	0	0
7 to 9 mos.	21	70	9	30	0	0
10 to 12 mos.	27	40	31	46	9	14
2 to 3 yrs.	14	37	14	37	10	26
4 to 5 yrs.	3	23	4	31	6	46

increase in the duration of symptoms, reaching a maximum at the 4 to 5 year duration period.

Our present conception of the clinical aspects of exophthalmic goiter permits certain correlations with the results of study of the pre-operative and postoperative blood iodine levels. Clinical experience attests to the view that certain features of thyrotoxicosis differentiate those individuals with acute recent onset and those who have been suffering from the disease for a considerable period of time. In this connection, the present results suggest that there may be an actual hypersecretion of iodine from the thyroid gland during the earlier stages of the disease. Such an interpretation, however, is only reasonable if the blood iodine level is influenced by excessive thyroid secretion. Should this hypothesis be adopted, it follows that subtotal thyroidectomy would remove the source of the excessive secretion with symptomatic relief. The elevated pre-operative and normal postoperative blood iodine levels of the cases of Group I lend credence to such a view.

The above hypothesis, however, does not appear to hold for the majority of individuals who have had untreated hyperthyroidism for 1 year. In these cases the pre-operative blood iodine level was generally found to be normal (10). That hypersecretion of iodine products from the thyroid gland could account for the symptoms of thyrotoxicosis seems doubtful. This becomes still more confusing when it is noted that, following surgical treatment, the blood iodine level usually increased to approximately twice the normal level (cases of Group II). Although 19.7 per cent of patients showing such a phenomenon had recurrence or persistence of hyperthyroidism, 73.7 per cent of the patients having similar blood iodine levels were considered to be clinically cured. At least in this group of cases (Group II) it is difficult to conceive that excessive thyroid secretion was a primary factor.

Furthermore, it would appear that, if the symptoms of clinical hyperthyroidism were allowed to persist untreated from 4 to 5 years, the blood iodine level is not only normal, but in most cases uninfluenced by subtotal thyroidectomy. The interpretation for these cases (Group III) would appear to be that the iodine metabolism, as reflected by the blood iodine level, is a secondary factor in very long standing cases of untreated hyperthyroidism.

The pre-operative level of iodine in the blood of patients with untreated hyperthyroidism can be used as an index of the amount of thyroid gland to be excised. We have correlated the postoperative results with the pre-operative blood iodine levels. Following operation, patients obtain complete relief or have recurrence or myxedema. In cases of Group I with an elevation of the pre-operative iodine in the blood, the unsatisfactory results are primarily due to myxedema, whereas the recurrence rate is very low. A less radical operation is indicated in this group of cases. The unsatisfactory results in Group II, with a normal pre-operative blood iodine level, are chiefly from recurrence; myxedema is rare in this group. The results in cases of Group III in which the pre-operative blood iodine is again normal, are very satisfactory. Since the pre-operative blood iodine is normal in both Group II and Group III, in order to decrease the recurrence rate of cases of Group II it becomes necessary to do a more radical subtotal thyroidectomy in all of the cases in both groups. This seems justified since there is a very low incidence of postoperative myxedema in both Groups II and III. These cases represent only 33.6 per cent of the total but all of the recurrences are found in these 2 groups. In view of the fact that it does no apparent harm and offers a definite opportunity for decreasing the number of recurrences, we strongly urge a radical subtotal thyroidectomy in all cases of hyperthyroidism in which the blood iodine level is normal pre-operatively.

SUMMARY

1. The pre-operative and postoperative blood iodine levels are reported for 256 cases of exophthalmic goiter; 100 of these patients were followed for 1 year.

2. Patients with hyperthyroidism having an elevated pre-operative blood iodine level showed a normal blood iodine level following subtotal thyroidectomy. The incidence of such cases decreased with an increase in the duration of symptoms before treatment.

3. The majority of patients with hyperthyroidism with symptoms for 1 year had a normal blood iodine level and following subtotal thyroidectomy had an increase in the level of iodine in the blood. The incidence of recurrence in these patients was 19.7 per cent.

4. After symptoms of hyperthyroidism have been present from 4 to 5 years, the blood iodine level was generally normal and usually uninfluenced by subtotal thyroidectomy.

5. Evidence is presented to show that the pre-operative blood iodine level can be used as an index of the amount of thyroid gland to be removed in patients with hyperthyroidism.

6. A radical subtotal thyroidectomy is recommended in all cases of hyperthyroidism with a normal or low pre-operative blood iodine level.

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THE INFLUENCE OF PAPAVERINE ON MUSCULAR TONE OF THE INTESTINAL TRACT

J. ARNOLD BARGEN, M.D., and RAYMOND J. JACKMAN, M.D., Rochester, Minnesota

IT has frequently been demonstrated that morphine sulphate causes an increase in the muscular tone of both the large and small intestine of man and that its administration results in an increase in the frequency and amplitude of the peristaltic waves as well as in the amplitude of the rhythmic contractions. These changes are not prevented by the usual doses of such antispasmodics as atropine.

We previously have suggested the similarity in the state of muscular tone existing in the bowel in cases of the severe toxemia of peritonitis and in cases in which the intestine was affected by morphine sulphate. Regions of contracted bowel, obstructive in nature, alternating with stretches of distended bowel, will be noted. In spite of this, morphine is probably the most commonly used drug for the relief of pain and postoperative discomfort, following gastro-intestinal operations. Likewise, it has long been used as the drug of choice to "splint" or put the bowel at rest in cases of peritonitis. Because of the intestinal hypermotility and obstructive type of contractures that morphine produces we decided to investigate the other alkaloids of opium as well as opium products that are intended to replace morphine or have advantages over the latter drug.

METHOD OF STUDY

Several patients, who previously had undergone a colostomy because of an intestinal lesion, kindly consented to submit to certain harmless and painless tests in order that they might assist us in this study.

The method of studying these drugs has been described elsewhere (2). It is a well recognized fact that such alkaloids as morphine, codeine, papaverine, narcotine, and thebaine all play parts in the action of opium. Different specimens of opium may contain variable amounts of each alkaloid but the average amounts of the various alkaloids found in opium are as follows: morphine, 10 per cent; narcotine, 6 per cent; papaverine, 1 per cent; codeine, 0.5 per cent; thebaine, 0.3 per cent; and narceine, 0.2 per cent. The other alkaloids occur in such small quantities in the crude drug that their action may be considered negligible.

From the Division of Medicine and the Section on Proctology, The Mayo Clinic.

RESULTS

Pantopon. Although the other alkaloids may modify the effect of opium, any action of this drug is the result of the comparatively large amount of morphine it contains. The view that opium is a more effective narcotic than morphine has been brought forth from time to time, and one comparatively recent preparation of the alkaloids as they exist in Smyrna opium has been introduced under the trade name of "pantopon." It has not been shown that the narcotic effect of this drug is greater than that of the morphine it contains. It has been said that pantopon has a greater sedative effect on the gastro-intestinal tract than has morphine. If this is true, the effect may be attributable to the papaverine it contains. Our observations suggest that morphine and pantopon act very much alike in increasing muscular tone, peristalsis, and the amplitude of contractions of the intestinal muscle.

Codeine. The action of codeine on the bowel was less striking than that of morphine, but when codeine was administered in large enough doses the action was essentially the same as that of morphine.

Papaverine. Allen and MacLean have described the antispasmodic effect of the intravenous administration of papaverine hydrochloride in cases of sudden arterial occlusion. They reported a case in which, after intravenous administration of papaverine, the circulation was re-established. In this case

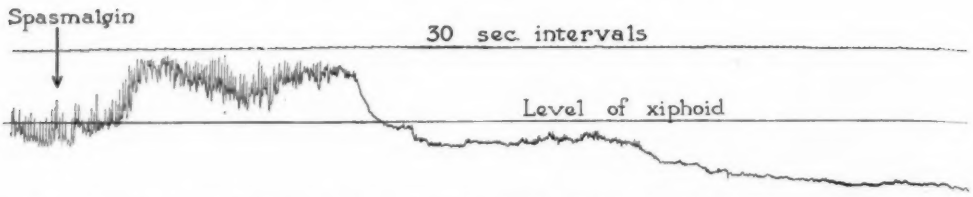

Fig. 1. Effect of 1 cubic centimeter of intravenous administration of papaverine compound (spasmalgin) on the muscular tone of the terminal portion of the ileum; the temporary increase in the tone and motility is the result of the alkaloid morphine in the spasmalgin; the subsequent decrease in the tone and motility continued for a period of 90 minutes before the normal tonus was gradually resumed.

morphine sulphate as well as intermittent suction and pressure (pavex treatment) had little value in relieving the pain or in re-establishing the circulation. Other writers have reported similar results with papaverine. In our study the intravenous administration of papaverine hydrochloride in doses of 1 to 1½ grain (0.065 to 0.097 gram), caused a decrease in tone of the intestinal muscle. This was not constant but an increase of tone was not observed when using papaverine in any of our cases studied.

Papaverine compound. This drug was introduced commercially under the trade name of "spasmalgin"; it contains papaverine hydrochloride 0.021 gram, "pantopon" 0.012 gram, and "atrinol" 0.001 gram in 1 cubic centimeter of the drug. The addition of the opiate and slower acting antispasmodic atropine, has been found to be advantageous in increasing the antispasmodic properties and controlling the pain which usually accompanies visceral spasm. As shown in Figure 1, the comparatively small amount of morphine that spasmalgin contains, although it manifests itself by the temporary increase in tone, is overcome by the papaverine and atropine so that the subsequent and desirable decrease in tone and immobility of the bowel is striking.

Lolling reported the use of spasmalgin in various types of angina and visceral colics, such as those associated with stones in the biliary ducts and ureters. In these conditions pantopon or morphine alone did not produce relief as effectively as did spasmalgin.

SUMMARY AND CONCLUSION

It is hardly necessary to call attention to the fact that morphine is one of the most valuable drugs in any physician's practice and we do not presume to supplant it or find a substitute. We would like to call attention, however, to the fact that morphine causes an increase in motility and tone of the large and small intestine of man. It may be that the constipating effect of morphine is attributable to the regions of spasm which it initiates.

The value of papaverine hydrochloride, as such, or in combination with pantopon and atropine, should be given serious thought. Clinically, this combination of drugs has been found to have great value in relieving the distressing abdominal cramps and frequent purulent, bloody discharges associated with the acute phase of chronic ulcerative colitis and other acute dysenteries. Experimental evidence has substantiated the antispasmodic effect of this papaverine compound.

Papaverine compound has certain advantages over morphine sulphate in cases in which it is desired to immobilize or put the bowel at rest.

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A STUDY OF THE FLUID AND SODIUM CHLORIDE BALANCE IN PATIENTS TREATED WITH CONTINUOUS SUCTION APPLIED TO INDWELLING DUODENAL TUBES

JOHN R. PAINE, M.D., and WALLACE D. ARMSTRONG, M.D.,
Minneapolis, Minnesota

ALTHOUGH suction applied to an indwelling duodenal tube has, in general, come to be accepted as the method of choice in the management of postoperative distention, occasional disconcerting reports, such as that of Taylor, appear in the literature in which it is alleged that the aspiration of the gastric and duodenal juices has produced serious dechlorination and dehydration. That the possibility of such an occurrence exists unless the fluid and sodium chloride balance is adequately maintained can not be denied. In our experience, however, at the University of Minnesota Hospitals, during the past 6 years no such occurrence has been recognized.

The changed blood chemistry which attends the loss of the upper gastro-intestinal secretions in high mechanical obstruction was first indicated by Hayden and Orr in 1923. In 1926, Walters and Bollman showed that similar changes occurred in dogs with experimental gastric fistulas. Four years later Ellman and Hartman showed that in dogs with complete loss of pancreatic secretion death occurred with characteristic changes in the level of the blood electrolytes. These experimental results have been confirmed by clinical study of patients. The deleterious effects of the loss of fluid *per se* have been studied in considerable detail. The fundamental studies of Gamble on the causes and effects of dehydration have been supplemented recently by the practical investigations of Maddock and Coller. These latter investigators have been concerned with the fluid requirements of surgical patients. Their results have indicated that such patients require more fluid than most clinicians have thought necessary heretofore.

From the Departments of Surgery and Physiology, University of Minnesota Medical School.

In the light of the above considerations it would seem desirable to determine the extent to which the acid-base and fluid balances of the body are disturbed by the use of suction applied to indwelling duodenal tubes for the removal of gas and fluid from the upper portion of the gastro-intestinal tract. The use of this method of treatment combined with the adequate administration of para-oral fluids gives eminently satisfactory results as far as decompression of the upper gastro-intestinal tract is concerned; but the amount of glucose and saline solutions which should be administered to each individual patient is a question which up to the present time has not been adequately investigated.

METHOD OF STUDY

This paper is based on the study of the sodium chloride and fluid balances of 19 patients on the surgical service of the University of Minnesota Hospitals.

Choice of patients for study. Patients were entirely unselected. All but one were subjected to a major surgical procedure and treated with suction applied to an indwelling duodenal tube during the period of the study. In some cases the studies were begun before operation and carried through the postoperative period for several days. In other cases the studies were begun immediately after operation. Two patients were studied in the relatively remote postoperative period.

Administration of fluid. Sixteen patients were allowed to drink as much water as they desired. No other fluid was offered by mouth. In 3 patients no oral fluid was allowed. Para-oral fluid of 3 kinds, normal saline solution, 5 per cent glucose in triple distilled water, and 5 per cent glucose in normal saline solution, was given in variable amounts and combi-

nations to the different patients. In certain cases the fluid administration was so controlled as to provide the optimum conditions for dehydration and alkalosis.

Aspiration of gastric and duodenal secretions. During the period of study all patients were treated with continuous suction applied to an indwelling duodenal tube. All of these tubes had perforations extending back from the tip some 8 or 9 inches so that even though the tip of the tube extended well into the duodenum, suction would be effectual in both the stomach and duodenum. The position of the tip of the duodenal tube was determined by an x-ray film of the abdomen in each case. Even though in many cases aspiration was confined wholly to the stomach, fluid was apparently removed from both the duodenum and stomach, as attested by its greenish-yellow color.

Collection of urine and aspirated fluid. The urinary output and duodenal tube aspirations were collected for each 24 hour period beginning at 8:30 a.m. All para-oral fluids, which in most instances were administered intravenously, were given between 9:00 a.m. and 9:00 p.m. Blood samples for the study of blood chemistry were drawn in the morning before the administration of any para-oral fluid. The urine was preserved by refrigeration and the addition of a small quantity of toluol.

Analytical methods. An aliquot of the aspirated fluid was filtered by suction through cotton. Free hydrochloric acid was determined by titration to the first transition interval of thymol blue. The total base was determined on 1 cubic centimeter aliquots by the method of Stadie and Ross. The accuracy of this determination was controlled by the analysis of standard potassium chloride solutions containing sucrase.

The specific gravity was determined and the quantitative tests performed on urine by standard procedures. The titratable acidity of urine was determined by the titration of 10 cubic centimeters of urine diluted to 250 cubic centimeters, phenol red being used as indicator. The end-point of the titration was 7.4 hydrogen ion concentration. A permanent phosphate buffer solution was used for reference. Alkaline urines were titrated to the same end-point with acid, and the result reported as acid deficit. Chloride was determined on aspirated fluid, urine, and blood by the method of Cavett and Holdridge. Some difficulty was experienced in the preparation of protein-free filtrates of the aspirated fluid by the method of Folin and Wu. In all such cases 5 per cent sulphosalicylic acid was found to remove effectively all protein from this fluid. The quantitative glucose determinations were made by Benedict's titration procedure. The results are reported in grams for total 24 hour samples. Standard procedures were used for the determination of the carbon dioxide combining power of plasma and for whole blood non-protein nitrogen analyses.

It was realized that a very significant determination was that of the amount of chloride excretion in the urine, and it seemed desirable to develop a highly simplified and rapid procedure for this determination which could be employed in the routine observation and care of patients. An attempt was made to adapt Purdy's method (8), but in our hands the original method gave inconsistent results. A modification of this method was made whereby 10 cubic centimeters of urine were treated in a conical graduated centrifuge tube with 5 cubic centimeters of 6 per cent silver nitrate in 0.03 normal nitric acid. The tube was centrifuged until the volume of precipitate was constant. By this technique 0.1 cubic centimeter volume of precipitate is equivalent to 3.36 milligrams of sodium chloride per 100 cubic centimeters of urine. The results agreed with the titration method within 5 to 10 per cent.

An alternative method and one equally adaptable to clinical use consists in the titration of 5 cubic centimeters of urine diluted to 100 cubic centimeters, with a standard mercuric nitrate solution. Three drops of a 5 per cent sodium nitroprusside solution is used as an indicator and the end-point is reached when a permanent turbidity is produced. This method is slightly more accurate than the centrifuge method.

RESULTS

The results obtained are presented in the accompanying table. The identification of the

patient, the diagnosis, the type of operation performed, and the position of the end of the duodenal tube are given. The volume of the urine and aspirated fluid together with the results of the analysis of each are presented. It will be noted that the complete analysis was not made in each case, but the determination of the sodium chloride content was made in practically every instance. With few exceptions the results of blood chemistry studies are given for each day. The two right hand columns of the table show the state of the measurable fluid balance and sodium chloride balance. No account has been taken of the water available from endogenous metabolism, the water lost in the feces, or that lost by vaporization from the skin. As Maddock and Coller have pointed out, these factors must be taken into account in any estimation of the patient's fluid requirements.

It will be noted at once that the amount of fluid aspirated through the duodenal tube varies roughly with the amount of fluid taken by mouth. This is to be expected since most of the fluid swallowed is immediately removed from the stomach by the tube. As the measured quantities of fluid show, however, this relationship is far from exact. Of more importance is the tendency of those patients with a relatively large fluid intake to lose greater amounts of chlorides in the aspirated fluid than do those patients with a more moderate oral fluid intake. Mr. W. C. who was encouraged to drink large amounts of distilled water illustrates this point most clearly. The results in the other patients would indicate that variations in the oral intake of water below 2,000 cubic centimeters for each 24 hours affect the chloride excretion in no characteristic manner. The average patient treated with suction applied to an indwelling duodenal tube loses up to 7.0 grams of chloride expressed as sodium chloride per day in the aspirated fluid.

The quantitative chemical analysis of the urine revealed no unexpected results. Others have called attention to the failure of the kidneys to eliminate chloride when the blood chloride level is decreased appreciably below the normal level. Patients, Mr. D. S., Mr. W. C., Miss R. J., Mr. F. S., Mr. V. S., were all given 1,500 to 3,000 cubic centimeters of 5 per cent glucose in triple distilled water each day for several days. Under these circumstances the daily excretion of chloride by the urine decreased steadily so that in some cases only traces could be detected. Simultaneously with this fall in urinary chloride the level of the plasma chlorides of the blood also fell. It would therefore appear that the chloride content of the urine represents the portion of this element that the body has no use for. Patients treated with suction, as well as other patients who excrete an appreciable amount of chloride in the urine, are receiving an adequate intake of this element and there exists little danger of achlorhydric alkalosis and uremia. As the study of the patients mentioned has shown, however, a good urinary output of over 1,000 cubic centimeters per day may be present despite an inadequate intake of sodium chloride if 5 per cent glucose solution is given para-orally in sufficient amounts.

The results of some of the qualitative tests on the urine specimens were surprising at first sight. Many of the urine specimens gave positive tests for acetone and diacetic acid, even though they contained large amounts of glucose. The formation of these ketone bodies is undoubtedly due to the fact that these patients, with a relative deficiency in carbohydrate, were forced to utilize their body fat to supply their caloric requirements. This phenomenon was noted in patients receiving as much as 3,000 cubic centimeters of 5 per cent glucose solution per day intravenously. None of the patients reported in this paper had diabetes mellitus as shown in the following table.

The importance of a moderately restricted oral and an adequate para-oral intake of fluid in the prevention of an abnormal alteration of blood non-protein nitrogen was indicated by the results obtained in the study of Mrs. V. S. This patient had had continuous suction applied to an indwelling duodenal tube 14 days preceding the study of his acid-base balance, but had received daily an average of 2,500 cubic centimeters of 5 per cent glucose in normal saline solution intravenously. The non-protein nitrogen of the blood was found to be 37 milligrams per cent on the fourteenth day.

TABLE SHOWING RESULTS

Identification of patient	Day of test	Position of tip of duodenal tube	Fluid intake						Fluid output			
				Para-oral fluid					Fluid aspirated by duodenal tube			
			Fluid by mouth c.cm.	5 per cent glucose in distilled water c.cm.	Normal saline solution c.cm.	5 per cent glucose in normal saline solution c.cm.	Citrated blood c.cm.	Total c.cm.	Volume c.cm.	Free HCl in c.cm. of n/10 acid per 100 c.cm.	Grams of sodium chloride	Total base milli-equivalents per 100 c.cm.
Mr. V. D.: Age 62 years; carcinoma of stomach; exploratory laparotomy 15 days before test	1	Stomach	1400		1200	1500		4100	1110	Slightly acid	2.08	45.2
Mrs. M. F.: Age 54 years; carcinoma of breast; radical mastectomy second day of test; transfusion reaction	1	Duodenum	1400					1400	840	15.6	3.44	46.5
	2				2000	1700	1300	5000	800	−2.5	2.55	62.1
Mr. J. H.: Age 68 years; carcinoma of stomach; exploratory laparotomy second day of test	1	Stomach	1000					1000	1210	37.0	6.36	65.0
	2		1130		2000		600	3730	975	Acid	4.22	61.5
	3		1200		3000			4200	475	−12.8	1.47	82.9
	4		2100		3000			5100	795	Alkaline	2.93	78.6
Mr. M. S.: Age 69 years; carcinoma of rectum; colostomy first day of test	1	Stomach		1500	4600			6100	540	3.3	4.29	
	2			3000	2400			5400	1325	1.3	14.85	
	3			2500	2400			4900	900	1.9	6.31	
	4			700	2400			3100	700	1.9	5.22	
	5			2300	2400			4700	900	2.3	7.52	
Mrs. F. H.: Age 61 years; carcinoma of rectum; colostomy first day of test	1	Stomach		1500	1800		500	3800	330	2.7	2.86	
Mr. C. K.: Age 18 years; acute appendicitis; appendectomy 7 days before test	1	Stomach				4000		4000	2110	11.9	4.35	34.5
Mr. A. S.: Age 52 years; carcinoma of stomach; gastric resection 1 day before test	1	Stomach	1250			2000		3250	700	Slightly acid	3.88	116.1
Mr. E. A.: Age 56 years; tuberculosis of colon; excision of stricture of colon on second day of test	1	Stomach	1500	500		1000		3000	3810	53.7	25.69	30.3
	2		1200			4150		5350	1050	Acid	5.15	51.9
	3		1200			3500		4700	1205	Very acid	6.12	73.7
	4		1400			3500		4900	2100	Acid	8.27	44.6
Mr. D. S.: Age 21 years; interval appendicitis; appendectomy second day of test	1	Stomach	600	1000				1600	1010	19.1	3.93	51.0
	2		30	1000				1030	445	25.9	2.24	71.5
	3		500	2000				2500	870	13.8	2.42	44.0
Mr. W. C.: Age 53 years; diagnosis reserved; no operation	1	Stomach	4000	3000				7000	4550	12.7	10.65	22.1
	2		3400	3000				6400	3325	13.3	8.52	31.3
	3		4950	2000				6950	5880	5.3	8.94	20.9
	4		3800	2500				6300	2945	18.3	7.88	32.1
	5		2200	1500		3000		6700	2540	15.7	7.60	

TABLE SHOWING RESULTS—Continued

Fluid output							Blood chemistry				
Urine											
Volume c.cm.	Specific gravity	Titratable acidity—c.cm. of n/10 acid per 100 c.cm.	Grams of sodium chloride	Glucose gm.	Acetone	Diacetic acid	Plasma—mg. NaCl per 100 c.cm.	CO_2 combining power—volumes per 100 c.cm.	Non-protein nitrogen in mg. per 100 c.cm.	Fluid balance c.cm.	Sodium chloride balance gm.
745	1.020	35.35	8.22	o	+	+	643.5	57.5	37.0	+1445	+14.0
440	1.006	30.83	4.17	o	+	+	651.6	55.9	25.0	+120	−7.6
685		Alkaline	5.89	o	+	+	674	50.3		+3515	+31.4
575	1.024	33.75	4.50	o	+	+	616.8	63.8		−785	−10.9
675	1.024	23.70	6.07	o	+	o	650.0	61.6		+2180	+10.6
570	1.026		4.04	o	+	+	661.8	54.0		+3155	+21.5
1120	1.025	Alkaline	9.64	o	+	+	654.8	57.0		+3185	+14.5
870	1.022	9.80	11.47	9.81	+	o	631.9	55.8		+4690	+25.6
715	1.017	16.60	4.61	o	+	+				+3360	+ 2.1
1900	1.007	13.40	5.72	o	+	+				+2100	+ 9.6
3500	1.006	3.77	15.19	o	o	o				−1100	+ 1.2
2030	1.007	3.17	9.30	o	o	o	605.3	61.5		−1770	+ 4.8
560	1.016	11.73	4.75	4.54	+	o	625.5	57.9		+2910	+ 8.6
1850	1.026	−88.64	18.05							+ 40	+14.5
1570	1.017	8.18	14.64	+	o	o	610.0	58.9		+ 980	+ .4
885		−54.28	5.01	+	o	o	572.0	74.9		−1695	−21.7
1200		23.24	6.97	+	o	o	666.5	59.7		+3100	+25.2
1495	1.023		11.48	+	+	+	640.7	59.7		+2000	+13.9
760		Alkaline	7.52	+	+	+	606.4	64.3		+2040	+15.8
1030	1.023	10.75	7.96	+	o	o	618.6	67.8	33.6	− 440	−11.89
250				+	o	o	596.9	66.6		+ 335	
950	1.026	Alkaline	1.63	+	+	o	596.7	67.6	35.8	+ 680	−4.05
1215	1.025	−0.55	3.80	+	o	o	641.1	60.3		+1235	−14.45
950	1.027	9.75	.99	+	o	o	606.7	68.7		+2225	− 9.5
760	1.028	32.10	1.55	+	+	o	562.4	68.1	24.1	+ 310	−10.4
940	1.024	22.70	Trace	+	+	o	517.6	82.6	24.8	+2415	− 7.88
1910	1.022	18.30	Trace	+	o	o	566.3	74.0		+2250	+19.4

TABLE SHOWING RESULTS—Continued

Identification of patient	Day of test	Position of tip of duodenal tube	Fluid intake						Fluid output			
			Fluid by mouth c.cm.	Para-oral fluid				Total c.cm.	Fluid aspirated by duodenal tube			
				5 per cent glucose in distilled water c.cm.	Normal saline solution c.cm.	5 per cent glucose in normal saline solution c.cm.	Citrated blood c.cm.		Volume c.cm.	Free HCl in c.cm. of n/10 acid per 100 c.cm.	Grams of sodium chloride	Total base milli-equivalents per 100 c.cm.
Miss R. J.: Age 32 years; acute appendicitis; appendectomy second day of test	1	Stomach	1800			3000		4800	1135	3.6	1.23	
	2		800	1500				2300	360	16.8	1.12	
	3		1400	3000				4400	480	34.4	2.41	
	4		2000	3000				5000	760	26.1	2.75	
Mr. J. W.: Age 65 years; revision of colostomy first day of test	1	Duodenum		2000	1500			3500	520		3.04	
	2		1000	3000				4000	1310		4.79	
	3		800	3000				3800	820		3.23	
	4		1500	3000				4500	510		1.90	
	5		800	3000				3800	620		3.29	
Mr. H. E.: Age 70 years; carcinoma of the colon; colostomy first day of test	1	Duodenum	1200	3000				4200	300			
	2		400	1500	1500			3400				
	3		1650	2800				4450	420		1.83	
	4		1600	3000				4600	680		5.02	
	5		2100	3000				5100	1150		1.79	
	6		1450	3000				4450	390		.95	
Mr. F. S.: Age 30 years; repair of inguinal hernia first day of test	1	Stomach	100	1500				1600	615		1.07	
	2		500	3000				3500	2275		1.05	
	3		230	3000				3230	2095		1.80	
	4		500	3000				3500	1525		4.60	
	5		500	1500	1500			3500	400		1.09	
Mrs. O. E.: Age 60 years; cholelithiasis; cholecystectomy first day of test	1	Stomach	650	3000				3650	450		.23	
	2		700	3000				3700	285		.83	
	3		450	3000				3450	300		.07	
Mrs. V. S.: Age 24 years; acute appendicitis with peritonitis	1	Duodenum	200	3000				3200	240		1.50	
	2		200	1500	1250			2950	690		3.70	
	3		400	3000				3400	1340		7.45	
	4		250	1500	1500			3250	750		3.70	
Mr. A. K.: Age 55 years; obstruction of colon; exploratory laparotomy; colostomy first day of test	1	Duodenum	1200	1500	1500			4200	1400			
	2		800	1500				2300	1245		2.24	
	3		1400	2000	1000			4400	1200		2.60	
	4		800	500	1000			2300	1595		6.38	
Mr. B. G.: Age 20 years; acute appendicitis; appendectomy 3 days before test	1	Duodenum	1200					1200	200	Slightly acid	0.70	58.7
Miss P. S.: Age 23 years; interval appendicitis; appendectomy first day of test	1	Duodenum	1200		1000			2200	835	Acid	2.90	39.8
	2		1600					1600	1200	11.2	3.08	33.5
	3		2200					2200	2880	23.5	7.17	19.0

TABLE SHOWING RESULTS—Concluded

Fluid output							Blood chemistry			Fluid balance c.cm.	Sodium chloride balance gm.
Urine											
Volume c.cm.	Specific gravity	Titratable acidity—c.cm. of n/10 acid per 100 c.cm.	Grams of sodium chloride	Glucose gm.	Acetone	Diacetic acid	Plasma—mg. NaCl per 100 c.cm.	CO_2 combining power—volumes per 100 c.cm.	Non-protein nitrogen in mg. per 100 c.cm.		
2315	1.013	16.00	3.90	32.10	+	+	597.9	59.7		+1350	+21.9
1655	1.007	10.69	1.69	12.40	+	+	599.7	63.5		+ 285	− 2.8
1790	1.005	4.81	1.28	10.75	+	+	604.6	63.2		+2130	− 3.6
1025	1.005	−26.30	.50	3.49	o	o	592.3	59.5		+3215	− 3.2
1885	1.020		14.70				588.0	70.0	40.0	+1095	− 4.2
2130	1.013		7.60				584.0	70.0	25.0	+ 560	−12.3
1580	1.014		3.47				564.0			+1400	− 6.7
910	1.018		2.54				568.0	69.0	54.0	+3080	− 4.4
1080	1.028		2.80				536.0	68.0	54.0	+2100	− 6.1
1200							600.0			+2700	
1200	1.010		4.50				585.0	59.0	43.0		
1685	1.005		6.50				598.0	69.0	32.0	+2345	− 8.3
2400	1.010		9.40				566.0			+1520	−14.4
1035	1.006		2.30				559.0	61.0	30.0	+2915	− 4.1
2450	1.007		7.30				560.0	60.0	30.0	+1610	− 8.2
440	1.020		.87				623.0	71.0	40.0	+ 545	− 1.9
390	1.005		.22				600.0	72.0	36.0	+ 835	− 1.3
740	1.018		.42				556.0	63.0	33.0	+ 395	− 2.2
1050	1.020		.73				546.0	72.0	34.0	+ 925	− 5.3
1465	1.017		11.10				632.0	71.0	38.0	+1635	+ 1.3
960	1.012		3.30				562.0	57.0	30.0	+2240	− 3.5
2010	1.005		3.30				586.0	69.0	30.0	+1405	− 4.1
1370	1.007		1.47				536.0	65.0	30.0	+1780	− 2.5
660	1.021		2.75				600.0	51.0		+2300	− 4.2
1175	1.021		3.60				507.0	59.0	46.0	+1085	+ 3.9
Incontinent	1.022						546.0	58.0	87.0		
460	1.012		.59				464.0	60.0	80.2	+2040	+ 9.2
360	1.016		20.30				584.0	67.0	29.0	+2440	
2235	1.022		19.22				490.0	60.0	31.0	−1180	−21.5
4180	1.015		2.10				572.0	71.0	35.0	− 980	+ 4.3
1845	1.011		8.48				612.0	71.0	41.0	−1140	− 5.9
920	1.021	−22.56	2.58	o	o	o	538.0	59.8		+ 80	− 3.3
490	1.020	25.62	3.84	o	+	+	657.6	61.6	29.5	+ 875	+ 2.3
640	1.025	24.78	5.23	o	+	+	662.4	57.5		− 240	− 8.3
345	1.030	32.53	1.32	o	+	+	634.1	56.6		−1025	− 8.4

In 2 patients, Mr. J. W., and Mrs. V. S., the blood non-protein nitrogen was definitely elevated. Mr. J. W. was a 65 year old man with mild hypertensive heart disease, and Mrs. V. S. was a 24 year old woman with localized peritonitis from a ruptured appendix. Some doubt exists as to the effect of dechlorination incident to gastroduodenal aspiration in causing the slight increase in the non-protein nitrogen in the case of Mr. J. W., but in the case of Mrs. V. S. it is probable that an inadequate intake of sodium chloride was an important factor in the elevation of the blood non-protein nitrogen level. It will be noted that in this case the blood chlorides fell and the carbon dioxide combining power rose.

Most of the patients studied show a carbon dioxide combining power of over 55 volumes per cent. Such values may indicate a mild alkalosis but these can scarcely be attributed to dechlorination, as equally high values are found in those patients with positive chloride balances as in those with negative chloride balances.

A study of the calculated chloride balance, expressed in terms of sodium chloride, shows that no patient who received 2,000 cubic centimeters or more of normal saline solution daily had a negative chloride balance. Furthermore, the negative balances which consistently occurred in those patients given only 5 per cent glucose in distilled water would all have been adequately covered by 2,000 cubic centimeters of normal saline solution. It has been the practice at the University of Minnesota Hospitals for the past 6 years to give patients treated with continuous suction applied to indwelling duodenal tubes between 2,000 and 3,000 cubic centimeters of normal saline solution each day with or without 5 per cent glucose. That such a regimen will consistently prevent dechlorination and alkalosis has been proved both by experience in hundreds of cases and by the results of the studies here reported. It is not meant to convey the impression, however, that exceptional cases will not occur from time to time in which some variation from this rule will not be indicated. It is our impression that in the usual patient treated with suction, to whom inadequate amounts of saline solution are administered, several days must elapse before any real harm is done by the dechlorinating effect of the gastroduodenal aspiration.

SUMMARY

The fluid and chloride balances of 19 patients on the surgical service of the University of Minnesota Hospitals treated by continuous suction applied to an indwelling duodenal tube have been studied. Most of these patients were subjected to major surgical procedures and the studies were made in the immediate postoperative period. The duodenal tube aspirations and the urine collected from these patients were subjected to certain quantitative analytical tests. The daily variations in the blood chlorides, carbon dioxide combining power, and non-protein nitrogen were followed. The quantity and character of the fluid intake was varied in certain patients. A description of the analytical methods used is given. Two practical clinical methods for the quantitative estimation of chloride in the urine are described.

CONCLUSIONS

1. The administration of 2,000 cubic centimeters of normal saline solution daily to the usual patient treated with continuous suction applied to an indwelling duodenal tube will maintain a positive chloride balance and prevent any serious alkalosis.

2. Several days (4 to 5) must elapse before dechlorination incident to the aspiration of the gastroduodenal secretions through an indwelling duodenal tube can do harm to a patient inadequately supplied with sodium chloride.

3. Many patients treated with suction applied to indwelling duodenal tubes will have ketone bodies in the urine despite the daily intravenous administration of 3,000 cubic centimeters of 5 per cent glucose in distilled water or normal saline solution.

4. The patient who excretes daily 3 or more grams of chloride expressed as sodium chloride in the urine is in no danger of achlorhydric alkalosis.

5. The patient's sodium chloride requirements can be as satisfactorily determined by measuring the quantity of chloride present in

the urine as by determining the level of the plasma chlorides and with considerable more facility.

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PRIMARY STREPTOCOCCUS AND PNEUMOCOCCUS PERITONITIS IN CHILDREN

A Study of 61 Cases with the Report of Two Interesting Recoveries

EDWARD T. NEWELL, Jr., M.D., Chattanooga, Tennessee

THE idiopathic or so called "primary" cases of peritonitis, caused by the Beta streptococcus and the various types of the pneumococcus, while not common in children, occur with greater frequency than is generally recognized. There is considerable variation in the treatment of these cases as can be ascertained readily by reviewing the literature of recent years. Some observers believe in surgical intervention, either early or late, along with medical procedures such as serum, etc., while others believe only in supportive measures. The question of the portal of entry remains obscure although the point has been much discussed.

This report reviews the available cases of primary pneumococcus and streptococcus peritonitis from the departments of surgery and pediatrics of the Johns Hopkins Hospital. It includes 2 remarkable recoveries which have occurred this year by newer methods of treatment and which the author has had the opportunity of following carefully. The first was a fulminating case of streptococcus peritonitis in a premature infant which recovered with sulfanilamide therapy. The second was a severe case of pneumococcus peritonitis Type I in which pneumococcus rabbit serum Type I was used with recovery. Both are reported in detail later in this paper. These cases offer hope that the mortality figures, which in the literature average from 80 to 100 per cent for streptococcus peritonitis and from 40 to 65 per cent for pneumococcus peritonitis, may be considerably reduced. The incidence of primary peritonitis in children has been variously quoted by European and American authors as between 2 and 10 per cent of the acute abdominal conditions in children. During recent years in the Harriet Lane Dispensary, 2 to 4 cases of pneumococcus peritonitis and 2 to 3 cases of streptococcus peritonitis are seen each year. The incidence is sufficiently high to warrant special study of this condition.

From the Surgical Pathological Laboratory, Department of Surgery, Johns Hopkins Hospital and University.
William Stewart Halsted Fellow in Surgery, 1937–1938.

ANALYSIS OF CASES

The cases have been derived from the records of the Harriet Lane Home for Children and from the department of surgery covering the past 25 years. There have been 25 cases of primary streptococcus peritonitis and 36 cases of primary pneumococcus peritonitis proved by bacteriological and pathological study. The mortality for the former group is 92 per cent, and for the latter group 61.1 per cent. Of the total 61 cases, 36 have come to autopsy and have had careful examination of all the organs, both in the gross and microscopically. For the sake of clarity, the 2 groups will be discussed separately and will be further subdivided.

PNEUMOCOCCUS PERITONITIS

Clinical. Most authors divide pneumococcus peritonitis into 2 groups: the severe fulminating cases, and the subacute cases. Some of the patients in the latter group are not seen until the acute symptoms are over and seek admission because of a peritoneal abscess. In the present study a somewhat different classification has been used. The cases of primary pneumococcus peritonitis have been subdivided into 3 groups. The first group is the so called "idiopathic" group consisting of 12 children. The mortality was 50 per cent in this group, there being 5 males and 7 females. The second group consists of 8 cases in which primary peritonitis was associated with an upper respiratory infection. The upper respiratory infection usually preceded the peritonitis, but when pneumonia

developed, the pneumonia was usually secondary to a fulminating pneumococcal peritonitis. There were 6 males and 2 females in this group with a mortality of 62.5 per cent. The third group consists of 16 patients who also had nephrosis as the predisposing cause. There were 11 males and 5 females in this group with a mortality of 68.7 per cent. This is the group in which pneumococcal peritonitis may recur several times, but the children eventually die in childhood due either to the nephrosis or a severe peritonitis. The high mortality from peritonitis in this group may surprise some observers, but the figure seems plausible as only those cases in which the peritonitis was proved by bacteriology or autopsy are included. Even in these cases, there was often a previous history suggesting an attack of pneumococcal peritonitis with recovery.

The age incidence in the cases of pneumococcus peritonitis is evenly distributed between the first and tenth year. This is in contrast to the streptococcus cases, the great majority of which occur between the ages of 6 months and 2 years. Contrary to many reports on pneumococcus peritonitis, which emphasizes the frequency in females, there does not appear to be any significant difference in the sex incidence. In fact in this series, there were more males who had the disease in both the streptococcus and pneumococcus groups, which suggests that the genital organs are not the chief portal of entry.

The clinical manifestations vary according to the severity of the disease. Abdominal pain is the cardinal symptom. It is usually diffuse, but unfortunately from the diagnostic standpoint it sometimes begins in the right lower quadrant. The mode of onset of the pain and its character are difficult to ascertain because of the age of the patient. Other important symptoms are loss of appetite with nausea, and persistent vomiting; fever and diarrhea are also common.

The duration of the symptoms before admission is usually from 1 to 4 days. This does not apply to the group with nephrosis, several of whom developed a respiratory infection while in the hospital and subsequently developed peritonitis. There is a small group of patients who have been seen 2 to 6 weeks following an attack of abdominal pain with vomiting and fever, and who, on examination, appear emaciated and have a large peritoneal abscess. These large abscesses usually occur in the pelvic region, but sometimes occur in the epigastric region simulating a pancreatic cyst.

Perhaps the most common finding upon physical examination is abdominal distention with tenderness to deep palpation. The degree of muscular rigidity and spasm is unreliable and in several cases the abdomen had been reported as greatly distended but soft with little tenderness. The children usually look sick and dehydrated and in a fulmination case may be in shock. Often an upper respiration infection is present, as demonstrated in one-fourth of this series, which may predominate the picture and focus all of the attention upon the lungs or ears. Any sudden rise in temperature with abdominal pain and vomiting in children with nephrosis is suggestive of pneumococcus peritonitis. The temperature usually ranges from 101 degrees to 104 degrees and the white blood count is generally higher than one sees in appendicitis, being between 20,000 and 40,000.

In the differential diagnosis appendicitis with peritonitis and a severe upper respiratory infection with abdominal symptoms must be ruled out. In these cases puncture of the abdominal wall with a spinal puncture needle and examination of the peritoneal fluid is of great value, provided a positive result is obtained. This procedure has been described by Neuhof and Cohen, Danzer, Pollock, and others. The present method of abdominal puncture, as described by Neuhof and Cohen in 1926 is a simple and safe procedure and is used whenever the necessity arises in the department of pediatrics. Danzer in a recent article stresses the importance of the interpretation of the positive and negative results, and emphasizes that only 1 or 2 drops of pus are necessary for diagnosis if a positive smear is obtained.

Treatment. There is a marked difference in the mortality figures in the cases of pneumococcus peritonitis in which patients were submitted to surgical drainage as compared to

those who were not. The 15 cases which were drained had a mortality of 26.6 per cent as compared to a mortality of 82.6 per cent in the 23 cases in which surgery was not attempted. However, these statistics need qualification. First, it is well accepted that surgical drainage is indicated in those cases in which localization has occurred, but in the early acute stages there is considerable disagreement as to the value of drainage. In this series, it is suggestive but not conclusive that early operation and drainage are of value. If the cases of nephrosis and all subacute or chronic cases are omitted, 14 similar cases of acute primary peritonitis remain. Of this number, 7 were drained early with a mortality of 42.8 per cent while the 7 which received only the same type of supportive measures, had a mortality of 85.7 per cent. No serum was given in either group. The only factor which is not identical in the 2 groups is that of age. The patients treated surgically are slightly older, especially those who recovered. In reviewing the whole series, it is clear that in general, the older the child, the better the prognosis. Whether age is the chief factor in the recovery of these children, it is difficult to state because of insufficient controls. Most of the children over 2 years of age were treated surgically, while most of the younger children were not treated surgically. It is interesting to note that 2 children who recovered, aged 20 months and 4 years, respectively, drained spontaneously from the umbilicus.

The use of serum has been advocated in pneumococcus peritonitis for some years. The reports in the literature have included excellent results as well as failures. Since the recent reports on anti-pneumococcus rabbit serum in the treatment of lobar pneumonia at the Rockefeller Institute, it seems likely that this type of serum may be of benefit in the treatment of primary peritonitis. According to Horsfall et al., horse serum anti-bodies have never been demonstrated in the pleural effusions of pneumococcus empyema, while the smaller rabbit serum anti-bodies readily diffuse into the pleural cavity. This same principle may apply to the peritoneum although the fact has not yet been definitely demonstrated.

Rabbit serum was given to only one patient with primary peritonitis and it apparently contributed to the recovery of this patient. It may develop that serum therapy will supplant the necessity of operation after a study of a large series of such cases.

In considering the differential diagnosis, it must be remembered that, unlike the streptococcic cases, the age incidence in pneumococcus peritonitis parallels the age incidence for appendicitis in children fairly closely, and sometimes appendicitis cannot be ruled out unless a positive peritoneal puncture has been obtained so that operation may be indicated. Case 1 reported below illustrates the difficulty which is encountered in making a proper diagnosis. While studying the present series, the author examined a colored girl, age 6 years, who was thought to have a ruptured appendix with generalized peritonitis. The diagnosis seemed so definite that pneumococcus peritonitis was not even considered, and operation was recommended. At laparotomy this proved to be a case of pneumococcus peritonitis.

It is suggestive but not conclusive that the proper treatment of pneumococcus peritonitis in the majority of acute cases is early surgical exploration with bilateral drainage in both lower quadrants, preferably by a laparotomy incision on the right, and a small stab wound on the left. This is the method which most of the surgical cases have received. Supportive measures, in the form of intravenous fluids and small transfusions, should be given as indicated. Nothing should be given by mouth until all nausea and vomiting have ceased. As soon as the pneumococcus has been typed, serum therapy should be given when possible.

CASE 1. A colored girl, age 6 years, was seen in the Harriet Lane Dispensary on February 25, 1938, complaining of abdominal pain and vomiting for 2 days. The pain was said to have started in the right lower quadrant which became worse after the mother had given the child castor oil. Physical examination revealed an acutely ill child with a temperature of 101.4 degrees, pulse, 140; respiration, 20; white blood count, 25,000; urine, negative; and vaginal smear negative for gonococci. Distention was not marked, but there was generalized lower abdominal tenderness and moderate muscle spasm. Rectal examination revealed tenderness on both sides but no masses. The throat, heart, and lungs

were negative. A diagnosis of appendicitis with peritonitis was made. After intravenous fluids, laparotomy was performed which revealed a generalized peritonitis which was thought to be of gonococcal origin although the fallopian tubes were not greatly inflamed. A normal appendix was removed and the wound closed without drainage. The report of the culture 2 days later from the peritoneal pus was pneumococcus Type I. This was also confirmed on the same day by blood culture. During the interval, the child had declined steadily with frequent vomiting, delirium, temperature 104.6 degrees, and the pulse rate averaging around 170 to 190 despite continuous intravenous therapy. As soon as the cultures were reported, she was transferred to Harriet Lane where, after negative conjunctival and intradermal test doses, a total dose of 205,000 units of anti-pneumococcus rabbit serum was given intravenously at 2 hour intervals over a period of 12 hours. There was rapid improvement, the temperature falling to 99.4 degrees at the end of 24 hours. She received 2 small transfusions of 150 cubic centimeters each on March 2 and March 8, 1938. The only serum reaction was a chill after the first injection and some incontinence 1 week later.

The ultimate recovery of this patient was long and protracted. Twenty-two days later the patient developed a consolidation of the lower lobe of the left lung, which was shown by x-ray. This cleared up but a mechanical intestinal obstruction developed which necessitated an exploratory laparotomy on April 19 and again on April 27 with release of adhesions and evacuation of a small pocket of pus. Culture of this pus was sterile. After this the patient steadily improved and was discharged May 16, 1938, more than 2½ months after admission.

Another interesting case of pneumococcus peritonitis has recently been admitted which is almost identical with the case just reported. The prompt improvement after receiving anti-pneumococcus rabbit serum warrants a preliminary report:

A colored girl, 8 years of age, was admitted on March 27, 1938, acutely ill with signs of generalized peritonitis. She had been sick for 2 days complaining of abdominal pain which began in the right lower quadrant. Vomiting and diarrhea followed 8 hours after the onset of her illness. She had been given castor oil on 2 occasions. At exploratory laparotomy, the appendix was normal but there was a generalized peritonitis from which a smear and culture were taken. Type I pneumococcus was typed from the smear and was later grown from the peritoneal and blood cultures. She received 300,000 units of anti-pneumococcus rabbit serum in the same manner as Case 1 with prompt improvement. Her convalescence was satisfactory until the patient developed a peritoneal abscess which was incised and drained, pneumococci being cultured from the abscess. After this procedure, the patient improved more rapidly and was discharged on April 20, 1938, 24 days after admission to the hospital.

STREPTOCOCCUS PERITONITIS

Clinical. These cases have been divided into 2 groups: the idiopathic group and the group associated with erysipelas. In the idiopathic group, there were 17 cases with a mortality of 88.2 per cent. There were 11 males and 6 females. In the erysipelas group the mortality was 100 per cent, there being 8 cases, 4 males and 4 females. Race is apparently of no importance in either the streptococcus or pneumococcus group, the proportion of white to colored children being approximately the same as the general admissions to the hospital.

The age incidence for streptococcus peritonitis differs considerably from the cases of pneumococcus peritonitis, most of these cases occurring in the first 6 months of life (18 of the 25 cases). This is of importance in diagnosis, as appendicitis in children is extremely uncommon before the age of 2 years according to Lipshultz, Lowenburg, Marsch, and others. Marsch's figures for 9,000 cases of appendicitis reveal that only 1.1 per cent occurred between the ages of 1 and 5 years.

The most important symptoms in the cases of streptococcus peritonitis in the order of their frequency are: vomiting, diarrhea, and abdominal pain. Many of these children are too young to reveal pain except by fretfulness and crying, particularly when the abdomen is touched.

The more important signs are an acutely ill, often moribund, child with considerable abdominal distention. The abdomen is tender to palpation but not board-like. In several of the cases the umbilicus and surrounding area for about 2 centimeters were red and swollen. Unfortunately, this is a late sign, which usually is seen in moribund infants. The children may have evidence of a streptococcus infection elsewhere, such as a pharyngitis, a cellulitis of the skin, or an otitis media. Leopold and Kaufman quote Mordlund's series of primary streptococcus peritonitis in which 63 per cent of the cases have a preceding upper respiratory infection.

The cases of primary streptococcus peritonitis all appear to have a fulminating type of the disease, there being no subacute or chronic types. The temperature is high from 103 degrees to 106 degrees, the white blood count ranges between 2,700 and 45,000. The low white blood count occurs not infrequently, along with a subnormal temperature, in children who are moribund and in shock.

In the cases associated with erysipelas, peritonitis usually develops as soon as the infection spreads to the region of the umbilicus. This would suggest that the infection of the peritoneum occurs by direct extension although a septicemia is usually present by this time. Study of the cases at autopsy suggest this mode of extension in 1 and perhaps 2 cases, but this cannot be shown in all cases.

Differential diagnosis consists in ruling out an acute dysentery, appendicitis, meningitis, and a severe respiratory infection. The peritoneal puncture is perhaps more valuable in these cases than in the pneumococcus group. Since the introduction of sulphanilamide, differentiation between streptococcus and pneumococcus is extremely important therapeutically.

Treatment. The conservative treatment of streptococcus peritonitis appears to offer the most at the present time, since the use of sulfanilamide has been shown to be of such value in Beta streptococcus infections. In reviewing the present series of cases, the mortality rate was 100 per cent in the 9 patients operated upon and 87.5 per cent in the 16 patients treated without operation. So far, sulfanilamide therapy has been given to 3 patients with primary streptococcus peritonitis, 2 of whom died and the third, a premature infant of 2 months, recovered. This case is reported below. The first patient who received sulfanilamide was a boy, aged 4 months, who had a laparotomy with drainage in December, 1936. Beta streptococcus was cultured and sulfanilamide given subcutaneously. The child survived longer than usual but died on the twelfth day. The other patient to receive sulfanilamide was admitted moribund and died within 6 hours.

In summarizing it should be emphasized that in the treatment of streptococcus peritonitis early diagnosis is of the greatest importance. This can usually be confirmed by peritoneal puncture eliminating the necessity for laparotomy. Sulfanilamide should be given as early as possible. The patient who recovered was given sulfanilamide both subcutaneously and intraperitoneally; normal saline and sodium lactate were also given intravenously to prevent acidosis, which occurs so readily when administering sulfanilamide to infants; supportive measures were given as indicated.

CASE 2. A premature colored boy was admitted to the Harriet Lane Home at the age of 1 day because of prematurity. His course was uneventful until the age of 2 months when he developed a severe respiratory infection accompanied by vomiting, diarrhea, and severe distention. Physical examination at that time revealed an acutely ill child, with a temperature of 104 degrees, pulse rate thready, respiration laborious, and a white blood count of 12,200. The urine was negative on examination. The abdomen was distended and there was definite generalized tenderness. A peritoneal puncture was performed and 5 cubic centimeters of purulent material obtained. A smear revealed streptococci in chains and the culture report was Beta streptococci. By 6 o'clock in the evening on November 28, 1937, the child was in shock and one-half cubic centimeter of coramine was administered. The first dose of sulfanilamide (30 cubic centimeters of a 1 per cent solution) was given intraperitoneally at 11 o'clock that night. The child received a second dose of 30 cubic centimeters intraperitoneally the next morning along with subcutaneous infusions of a 1 per cent solution twice a day for 5 consecutive days. The average subcutaneous dose was 40 cubic centimeters or 0.4 gram of sulfanilamide. A one-sixth molar solution of sodium lactate was given along with the sulfanilamide to combat acidosis. Frequent small blood transfusions of 30 to 40 cubic centimeters were also given. Under this regimen, the infant improved steadily. Two weeks later a scrotal abscess developed. This was incised and drained, Beta streptococci being obtained from the culture. Sulfanilamide was again given along with 3 additional blood transfusions. The infant recovered and was discharged on January 1, 1938, 1 month after the peritonitis developed. This is apparently the youngest case which has recovered from a primary streptococcus peritonitis that has been reported in the American literature.

BACTERIOLOGY AND PATHOLOGY

The question of the etiology and the mode of entrance of the organisms into the peritoneal cavity is discussed in most papers on primary peritonitis. The 3 modes of entrance

generally considered are: (1) the blood stream; (2) the intestinal tract; and (3) the genital organs of the female. Perhaps the viewpoint of Cole who thinks that there is probably more than one avenue of entrance is most logical. The blood stream seems to be the most common pathway, but why the peritoneum is selected by the organisms is open to speculation. A careful study of the 36 autopsies in this series does not aid in clarifying this point. Studies from a physiological viewpoint might prove helpful.

A study of the cultures of the organisms obtained in these 2 groups is of interest. The typing of the pneumococcus is important in selecting the cases in which horse or rabbit anti-pneumococcus serum may be readily used. Thus in the 36 cases the type of pneumococcus was as follows: Type I, 5 cases; Type II, 4 cases; Type III, 2 cases; Group IV, 14 cases; not typed, 11 cases; total number of cases 36.

A positive blood culture was obtained either before or after death in 17 of the 25 cases in which it was attempted, the vast majority being premortem cultures. In the 29 cultures of the peritoneal material all were positive for pneumococcus. Eleven throat cultures were taken, 8 of which were positive with the same type pneumococcus as was obtained from the blood or peritoneal culture. Sporadic cultures were also taken from the vagina, spinal fluid, colon, and lungs. There were 6 positive lung cultures and no positive vaginal cultures with the same type organism as in the blood or peritoneum.

In considering the bacteriology of the 25 streptococcus cases, the Beta streptococcus was cultured from either the blood or peritoneal fluid in 24 cases, an unusual Gamma streptococcus being cultured from both the blood and the peritoneal fluid in the other case. There were 21 positive blood cultures and 4 negative cultures. There were also 21 positive peritoneal cultures and 1 negative culture. Sporadic cultures were also taken from the vagina, urine, stools, spinal fluid, throat, lungs, and skin. There were 5 positive and 2 negative throat cultures and unlike the pneumococcus group, there was 1 positive and 1 negative vaginal culture. There was also 1 positive culture from a scrotal abscess, and 4 positive cultures from the skin of erysipelas patients.

SUMMARY AND CONCLUSIONS

Twenty-five cases of primary streptococcus peritonitis and 36 cases of primary pneumococcus peritonitis have been studied. One case of primary streptococcus peritonitis which recovered with sulfanilamide therapy, has been reported in detail. One case of primary pneumococcus peritonitis, Type I, which reacted favorably to anti-pneumococcus rabbit serum Type I, has also been reported in detail. The clinical findings, bacteriology, pathology, and treatment have been analyzed. No definite avenue of entrance could be found to explain the spread of the organisms into the peritoneal cavity, but it seems likely that there are several pathways of entrance, the blood stream being the most common way through which the organisms reach the peritoneum.

The mortality figures are quite high for both the streptococcus and pneumococcus cases of primary peritonitis. Two newer methods of treatment, i.e., sulfanilamide, and anti-pneumococcus rabbit serum, are reported, and it is hoped that after a longer period of trial the mortality figures will be reduced considerably by these methods. In considering the surgical results of these 61 cases, it is suggestive that early laparotomy with drainage is of definite value in selected cases of pneumococcus peritonitis, and of no value in the cases of streptococcus peritonitis.

A summary has been made of the 36 cases of streptococcus and pneumococcus peritonitis which came to autopsy in the department of pathology.

No mention has been made of primary peritonitis in adults although it does occur less commonly than in children. Two fulminating cases of adult Beta streptococcus peritonitis have come to autopsy this year in which the infection was thought to have arisen in association with chronic gonococcal salpingitis.

The author wishes to express his appreciation for the permission given him by Dr. Edwards A. Park to include the cases from the department of pediatrics of the Johns Hopkins Hospital in this report, and to Dr. Charles Geschickter and Dr. Arnold Rich for their constructive suggestions.

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ARRHENOBLASTOMA

MALCOLM B. DOCKERTY, M.D., and WILLIAM CARPENTER MacCARTY, M.D.,

Rochester, Minnesota

IN 1905, Pick, of Germany, first described a peculiar ovarian tumor composed, in the main, of epithelial elements in tubular arrangement different from any structure found in a normal ovary but bearing a strong resemblance to adenomatous tissue found and described in connection with the gonads of male pseudohermaphrodites. He considered this tumor as being of the nature of an enlarged ovotestis and called it a testicular tubular adenoma. Schickele, in 1907, and Bell of England, in 1915, reported similar examples, the latter giving a detailed report of a girl, aged 18 years, who presented a symptom complex consisting of amenorrhea, hirsutism with a male distribution of hair, atrophy of the breasts, changes in the voice, and the presence of a left ovarian tumor. The syndrome, which had developed within a period of 18 months, retrogressed completely to a condition of normalcy following removal of the affected ovary. Pathological study of the surgical specimen revealed what Bell considered an example of a tumor in an ovotestis. He described, along with the tubular and adenomatous structures noted by Pick, certain interstitial cellular elements which, when stained with sudan III, were seen to contain lipoid within their cytoplasm.

Meyer, over the period from 1915 to 1918, in an extensive study, found 17 instances of ovarian tumor of a similar nature. He noted the frequent occurrence of the peculiarly associated symptom complex and gave the tumor the name it now bears, "arrhenoblastoma." His work on the histogenesis of this tumor brought him to the conclusion that it arose from undifferentiated testicular remnants caught up in the ovarian hilus during early embryological development. From his rather large bulk of material he found that there were 3 pathological types of arrhenoblastoma: (1) that having a tubular pattern, (2) that having a diffuse or sarcomatoid structure, and (3) that representing an intermediate form in which the cellular elements of the tumor had a cylindroid arrangement. He recognized that the masculinizing syndrome was associated principally with the latter 2 types. He regarded the tumor as being of a low grade of malignancy, only one of his patients dying of metastasis, although several of his patients went through normal pregnancies following removal of the tumor.

Moots, in 1921, described the first case reported from this continent. In spite of a typical clinical and pathological picture of arrhenoblastoma and the fact that his patient had a complete return to normal following operation, he described the condition in the older terminology of "lateral partial glandular hermaphroditism."

Popoff, Spielman, Novak and Long, Mathias, Meyer, and more recently McLester, have reported cases of arrhenoblastoma. In 1933, there were some 26 cases reported in the literature; since then this number has been increased to more than 30.

HISTOGENESIS

As with the origin of other tumors of the ovary, there is no universal agreement regarding the parent tissue from which these tumors develop. Meyer, Goodall, Novak, and others champion the theory that these tumors arise from embryonic rests in the ovarian hilus and that these rests differentiate along male lines. Meyer has found embryonic remnants of seminiferous tubules in the hilus of otherwise normal ovaries, and Popoff discovered a small nodule arising from similar structures resembling in miniature the picture of arrhenoblastoma. The tumor studied in the case reported by Bell was only the size of a plum and appeared to arise from hilar structures because it possessed, at the periphery, an

From the Division of Pathology, The Mayo Foundation, and the Section on Pathology, The Mayo Clinic.

Fig. 1.

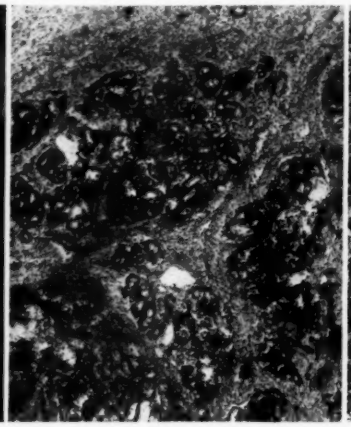

Fig. 2.

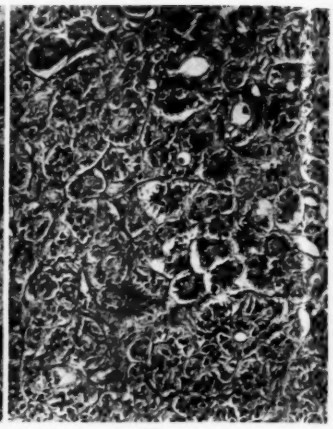

Fig. 3.

Fig. 1. Case 1. Showing absence of adhesions.
Fig. 2. Case 1. Alveolar arrangement of cells. Note areas of dark staining interstitial cells (sudan III ×30).

Fig. 3. Case 2. Showing typical characteristics of testicular tubular adenoma. Few interstitial cells are noted. ×120.

investment of ovarian cortical tissue. Others, prominent among whom is McLester, believed that the tumor represents a one sided development of a teratoma. In the tumor reported by McLester, there were cysts lined with large mucus producing cells bearing no resemblance to normal ovarian structures or to the cellular elements in other parts of the tumor. He pointed out the fact that, in some instances, it may be difficult to find anything except thyroid tissue in an ovarian teratoma and postulated that the same is probably true as far as testicular elements are concerned. The question is still unsettled.

PATHOLOGY OF ARRHENOBLASTOMA

The gross appearance of these tumors is more or less characteristic. Meyer, Neumann, and McLester noted the smooth, grayish surface without adhesions and without invasion by tumor cells. As in Bell's and Neumann's cases, this is supposed to represent the stretched out remains of ovarian cortex, the tumor arising from medullary remnants. Microscopically, Meyer found 2 cellular types, the large polygonal cell with clear cytoplasm and a dark staining clearly outlined nucleus with a prominent nucleolus. The other was a spindle cell which he considered to be a modified epithelial cell. The epithelial elements were arranged in 3 definite patterns: (1) an alveolar or tubular pattern with central lumens either empty or containing a homogeneous secretion, the lining cells being large, polygonal and in orderly arrangement; (2) a disposition in solid cords or anastomosing strands, the so called intermediate group; and (3) a diffuse or *sarcomatoid* arrangement. Mitotic figures have been found but are not frequent and the degree of differentiation together with this and other features indicate a low grade of malignancy.

Spielman, Bell and, more recently, McLester, have demonstrated the presence of lipoid globules within the cytoplasm of both the large polygonal cells and the fusiform cells. These droplets are supposed to have a peculiar disposition in a crescentic fashion around vacuoles in the cytoplasm. The picture closely resembles that of the interstitial cells of the testis, studied by Crew, and these peculiar cells are purported to play the rôle of producing the secondary sex characteristics observed through the elaboration of the male sex hormone. In the first 3 cases reported below, lipoid droplets were a prominent feature in the cytoplasm of the large polygonal cells. In the second case, a gradual transition is seen between these epithelial elements and

Fig. 4 a.

Fig. 4. Showing multicentric character of tumor which was noted in all 4 cases: a, above, Case 2; b, below, Case 4.

Fig. 5. Case 3. Showing smooth, rounded contours of the tumor.

the so called interstitial cells mentioned by other writers.

CASE REPORTS

The following 4 examples of arrhenoblastoma were found in an examination of the material collected from the museum of The Mayo Clinic in the period from 1910 to 1936 inclusive. The tissue was old and fixed in formalin and the histories were not taken with special reference to a diagnosis of this type of neoplasm, but the cases contain so much of interest from clinical and pathological standpoints that they deserve more than passing consideration. Multiple blocks were taken from these tumors and were studied from frozen and paraffin sections. They were stained with hematoxylin and eosin, sudan III, and by the Galantha method for mucin.

CASE 1. A married, white primapara, aged 25 years, registered at the clinic October 15, 1934. Her past medical history was negative except for having had an appendicectomy performed in 1926, at which time pelvic exploration had revealed no abnormality. In 1930 she had experienced a normal pregnancy.

Her present illness had dated back 2½ years when, following 4 months of menorrhagia, her menses had suddenly ceased. Coincidentally with

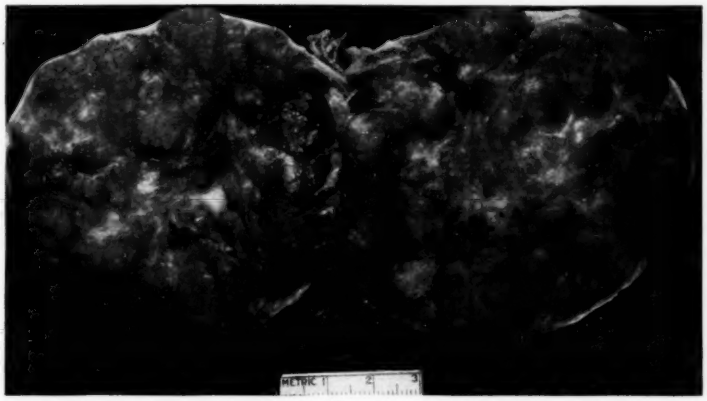

Fig. 4 b.

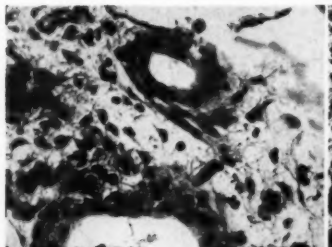

Fig. 6.

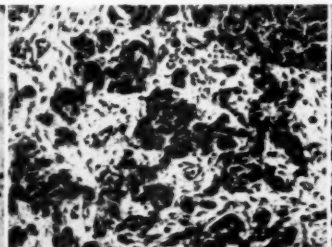

Fig. 7.

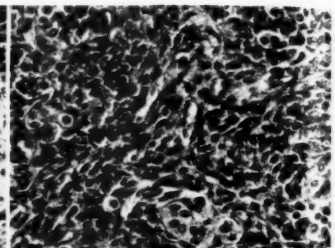

Fig. 8.

Fig. 6. Case 3. Mixed type of arrhenoblastoma showing tubular elements. ×280.

Fig. 7. Case 4. Cylindroid pattern predominates. ×115.

Fig. 8. Case 3. Diffuse pattern with a large number of pale, interstitial cells; associated with extreme signs of masculinization. ×175.

the onset of amenorrhea she had noted an overgrowth of facial hair, which had gradually increased in amount until shaving had become a frequent necessity. She had gained 20 pounds since the beginning of her illness and had complained of recurrent attacks of mild pain in the left lower abdominal quadrant.

Physical examination revealed an obese white woman with a somewhat boyish figure and a distinctly masculine distribution of hair. There was extreme hypertrophy of the clitoris and moderate atrophy of the breasts. Erythematous patches were present in the skin over both legs. Pelvic examination disclosed a tender mass in the left adnexal region. Her blood pressure was 98 millimeters of mercury systolic, and 60 diastolic. The only positive laboratory finding was the Allen-Doisey reaction for an excess of urinary prolan (66 units). Roentgenological examinations of the sella gave negative results. The basal metabolic rate was minus 9.

At operation on October 23, 1934, a solid tumor of the left ovary was removed and a biopsy was performed on the right ovary. Convalescence was uneventful and the patient returned home on the thirteenth postoperative day. Twenty-eight days following her operation she had a normal menstrual period. One year later she gave birth to a baby boy. At a subsequent examination, 2 years after her first visit, the right ovary was palpably enlarged. There was still present moderate hirsutism and the clitoris still was somewhat enlarged. Tests of the urine for prolan, however, gave negative results.

On pathological examination, the solid tumor was 5 centimeters in diameter and its surface was smooth and glistening (Fig. 1). On section the mass was grayish-brown in color and solid throughout, but with multicentric nodules of greater density. Microscopically, in the capsular zone of the tumor there were graafian follicles and corpora albicantes, the stretched out remnant of normal ovarian tissue. Underneath this, the tumor contained trabeculated strands of large polyhedral cells in tubular or alveolar arrangement, but with intervening solid cords of pale staining *interstitial* cells (Fig. 2). The cytoplasm of the polyhedral cells was clear or finely reticulated, the nuclei were small and dark staining with nucleoli relatively pin point in size. Mitotic figures were scarce. Stains for lipoid showed the presence of fatty droplets in the cytoplasm of both cellular types, but without any special intracellular distribution. The typical *sarcomatoid* pattern was not observed. The entire picture resembled that characteristic for the group classified by Meyer as not usually giving rise to symptoms of masculinization. Evidence pointing to a teratomatous origin of this tumor could not be found. Sections of the specimen removed from the right ovary for biopsy were normal.

Case 2. A single, white nullipara, aged 31 years, registered at the clinic March 20, 1931. She complained of an abdominal swelling and hypertrichosis of 2 years' duration. Her family history and personal history were irrelevant. Her menses had been regular until 3 months prior to registration when her "period" stopped abruptly. This was followed by 2 episodes of bleeding, regularly spaced, but small in amount. There had been considerable gain in weight over the period of her present illness.

Examination revealed the following positive features: (1) pituitary type of adiposity; (2) heavy growth of hair over the body with a masculine type of distribution; (3) hard pelvi-abdominal tumor

extending half way to the umbilicus; and (4) blood pressure of 165 millimeters of mercury systolic, and 90 diastolic.

At operation on March 26, 1931, a hysterectomy and bilateral salpingo-oophorectomy were performed for a solid neoplasm of the left ovary. Fifty cubic centimeters of straw colored fluid were present in the pelvis but evidence of local extension or of distant metastasis was not found.

This patient was given a course of colloidal lead phosphate intravenously. Six months later at a subsequent examination, there was no evidence of recurrence. Hypertrichosis was still present although not to such a severe degree as formerly.

On pathological examination, the uterus, right tube, and right ovary presented no remarkable features. The left ovary was replaced by a solid mass measuring 20 by 15 by 14 centimeters of smooth surface and without adhesions. On section, as in Case 1, the neoplasm contained multicentric grayish brown nodules of tumor tissue separated from one another by trabeculæ of connective tissue and containing in their center tiny cystic spaces filled with coagulated fluid (Fig. 3). Surrounding the tumor proper was a rind of edematous ovarian stroma 3 millimeters in thickness (Fig. 4).

Microscopically the picture differed little from that of Case 1 except for a relative absence of *interstitial* cells and the presence of small cysts. All these cysts were lined with a type of epithelium similar to that forming the tubular structures of which the tumor was mainly composed. Stains for lipoid demonstrated but minimal amounts of this substance, the tumor being an almost pure testicular tubular adenoma (so called).

CASE 3. A single, white nullipara, aged 15 years, registered at the clinic on March 1, 1937, complaining of amenorrhea and an abnormal growth of hair over the body. Her family history and personal history had been essentially negative except for an appendicectomy for acute appendicitis at the age of 13 years. Menses had begun at the age of 12 years and, for 12 months, had been regular. Following her appendicectomy she did not menstruate for 2 months and then had one period of scanty flow. She had not menstruated since then. Nine months prior to admission she had noted that her voice was becoming husky and, several months later, had observed atrophy of the breasts. For 3 months there had been a definite growth of facial, axillary, and pubic hair. A persistent acne had developed.

Positive physical findings were limited to the coarse voice, hypertrichosis with a male pattern of distribution, atrophy of the breasts, and hypertrophy of the clitoris. There was an acneiform type of cutaneous eruption. Pelvic examination disclosed a right ovarian tumor. Her blood pressure was 118 millimeters of mercury systolic, and 80 diastolic. Her basal metabolic rate was minus 7.

At operation on March 4, 1937, a right salpingo-oophorectomy was done for a solid tumor of the right ovary. The uterus appeared small. The left adnexa were grossly normal. The patient was discharged on the fifteenth postoperative day. At a subsequent visit 3 months later she was menstruating regularly and there was great diminution of her previous symptoms of masculinization. Urinary estimations for prolan gave negative results.

On pathological examination, the right ovary was the site of a solid tumor measuring 7 by 6 by 5 centimeters. This tumor had the same general gross characteristics as those described in Cases 1 and 2 (Fig. 5). Microscopically the tumor had all the features which mark the maturation of an arrhenoblastoma. The majority of sections had a diffuse arrangement of closely packed oval dark staining cells. In other regions, the picture was that of cuboidal dark staining cells arranged in solid cords (Figs. 6 and 7). Careful search revealed a tubular arrangement with transition to the other patterns in many areas. Scattered diffusely, or aggregated in small groups, were large pale cells with vacuolated cytoplasm. Stains for fat demonstrated the presence of lipoid droplets within the cytoplasm of these cells. Sections through the capsule of the tumor revealed many small graafian follicles containing degenerated ova. Corpora lutea were not seen. This tumor represents the type of arrhenoblastoma which, as Meyer has pointed out, is almost invariably productive of the masculinizing syndrome (Fig. 8). This illustration presents a diffuse pattern with a large number of pale, interstitial cells, associated with extreme signs of masculinization.

CASE 4. A white multipara, aged 51 years, registered at the clinic on May 2, 1930, because of postmenopausal bleeding. Her family history and personal history were negative. Her menses, prior to the climacterium at the age of 48 years, had for years been irregular, scanty and, at times, were spaced 3 to 4 months apart. During the 2 years prior to registration she had experienced 2 prolonged episodes of daily vaginal spotting. The last episode had begun 4 months prior to admission and had continued until the time of admission. Examination revealed multiple uterine fibromyomas and a firm mass in the right side of the pelvis. Laboratory data were negative.

At operation on May 9, 1930, a total abdominal hysterectomy was done with removal of both adnexa for uterine fibromyomas and a right ovarian tumor. The patient had an uneventful convalescence and was given a course of deep roentgen therapy before she went home. She was living when last heard from in 1937.

On pathological examination, the uterus was the site of multiple fibromyomas measuring as much as 4 centimeters in diameter (Fig. 4). There was an endometrial polyp at the fundus. Both tubes and the left ovary were essentially normal. The right ovary was the site of a solid tumor of a description similar to that of the other cases. Microscopically, as in Case 3, the tumor contained all 3 cellular patterns of Meyer's classification. There was, however, an almost complete lack of interstitial cells.

DISCUSSION

In the presence of a palpable pelvic tumor, associated with the masculinizing syndrome, a diagnosis of arrhenoblastoma seems justified. However, basophilic pituitary adenomas, pinealomas, and adrenal cortical tumors may be associated with a similar clinical picture. Certain features help in distinguishing between them. Hypertension, a cardinal symptom of adrenal and pituitary neoplasms, is unusual in cases of arrhenoblastoma. A definite increase in weight with a "buffalo" distribution of fat is associated frequently with an adrenal or pituitary neoplasm but may occur in association with ovarian tumor. Acne seems to occur frequently with all these conditions and was observed in 2 of the cases studied. Pituitary changes of a hyaline nature have been encountered in cases in which death has occurred owing to arrhenoblastoma. This leads to the question of whether or not this master gland may not be the basis of secondary sex changes. Positive prolan tests would point to such a conclusion.

Granulosa cell tumors offer the only difficulty in making a differential diagnosis histologically. The pathological characteristics of both tumors have a certain similarity but *interstitial* cells are absent in granulosa cell neoplasms and tubular structures are almost never observed. From a hormonal standpoint they are entirely different, granulosa cell tumors containing large amounts of estrin without prolan and the reverse being true in cases of arrhenoblastoma.

Most authors are now agreed that more than 80 per cent of these tumors are clinically benign. Malignancy in an arrhenoblastoma is shown by the usual criteria of multiple mitotic figures, irregularity in the size and staining properties of the nuclei and local invasion. It can be recognized in fresh sections of tumor tissue and, when present, warrants radical operation. Treatment, especially among younger individuals, should otherwise be conservative.

There are cases on record like Case 2 in the present series, in which pregnancy has ensued following local resection. Recurrences in the preserved ovary are infrequent. Little is known of the effect of radiation on these tumors because of the small number of reported examples. Some authors hold that arrhenoblastomas are highly radiosensitive.

SUMMARY AND CONCLUSIONS

1. Four cases of arrhenoblastoma are presented.

2. The clinical syndrome of sterility with amenorrhea, hirsutism, atrophy of the breasts, hypertrophy of the clitoris, and changes in the voice were all noted in 2 cases. In one case absence of follicular hormone with an increase of anterior pituitary hormone was found on examination of the urine.

3. Production of hormone by these tumor cells is probably linked up with lipoid metabolism.

4. These tumors are of but a low grade of malignancy, in most instances responding well to local surgical removal.

5. These tumors probably arise from embryonic structures within the ovarian hilus, growing and differentiating along male lines.

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SPONDYLOLISTHESIS

EVERETT MOORE GEORGE, A.B., M.D., C.M., New York, New York

IN THE 27 year period from 1911 to March 1, 1938, more than 210,000 patients have been examined at the New York Orthopædic Dispensary and Hospital. The diagnostic classification of the case histories of these patients revealed 313 individuals presenting evidence of spondylolisthesis or spondylolysis, all confirmed by roentgenographic studies. This paper is a comparative study of the conservative and operative treatment of this group as a whole.

DEFINITION AND ETIOLOGY

The term, spondylolisthesis, implies a failure of union of the laminæ to the pedicles together with an associated slipping forward of the body of a vertebra, usually in the lumbar region of the spine. Spondylolysis, previously termed *prespondylolisthesis*, implies a congenital non-union of the laminæ without forward displacement of the vertebral body.

The author believes the etiology of the lesion is essentially a congenital developmental defect in the interarticular portion of the involved vertebra. Willis has demonstrated that a lumbar vertebra is formed from 5 centers of ossification, 1 for the body and 2 for each half of the posterior arch. Of the latter, 1 anterior center forms the pedicle, including the superior articular facet, and 1 posterior center forms the lamina with the inferior articular facet. Rambaud and Renault, in 1864, referred to the formation of the neural arch by union of lateral anterior and posterior centers of ossification. If these lateral centers of ossification fail to unite, a defect results on each side between the superior and inferior articular facets and a separation of the body from the posterior arch.

In spondylolisthesis the lumbar vertebral body becomes narrower and the sacrum broader in the anteroposterior plane, due to developmental response to strains. This indicates that the defect has been present for some considerable time, certainly longer than the period incident to the usual history of any associated trauma with the onset of symptoms. Capener noted that bone often proliferates from the anterior surface of the sacrum beneath the displaced portion of the fifth lumbar vertebra, forming a buttress which tends to prevent further slipping. A study was made of the roentgenograms of 108 consecutive lumbosacral spines, which happened to include 9 cases of spondylolisthesis. In 80 of these patients the body of the fifth lumbar vertebra was broader than the sacrum, or in 74 per cent of the spines studied. A comparable study of roentgenograms of 125 patients with spondylolisthesis revealed the sacrum to be broader than the fifth lumbar vertebral body in 91 cases, or in 73 per cent of the spines studied. The average broadening of the sacrum for the latter 125 cases was 0.08 inch.

A fracture dislocation of the spine resulting from trauma may simulate spondylolisthesis in late clinical symptoms and in roentgenograms. It is well known that severe trauma to the lumbosacral region can occur without spondylolisthesis resulting. In 5 patients in this series, each of whom gave a history of severe trauma at the onset of symptoms, roentgenographic evidence points to the trauma as the exciting factor in the origin of the deformity. Three of this group exhibit a fracture dislocation of the spine at the fourth lumbar vertebra, and the 2 other patients show fracture dislocation at the fifth lumbar vertebra. One hundred and nine other patients in this study gave a history of definite trauma which was usually associated with the time of the onset of symptoms, and varied markedly in degree. No posterior displacement has been observed associated with the lesion of spondylolisthesis. Junghanns has described a *reverse-spondylolisthesis*, in which there is posterior displacement of the vertebral body associated with arthritis deformans at the articular facets, but no patient in this

Annie C. Kane Fellow, New York Orthopædic Dispensary and Hospital.

series exhibited this deformity. Posterior displacements of a vertebral body are frequently observed developmentally and as a result of trauma.

Five patients in this series presented an increase in the anterior displacement of the affected vertebral body while under observation, varying from one sixteenth to five-eighths inch. It is noteworthy that 2 of these patients developed spondylolisthesis following previous definite roentgenographic evidence of spondylolysis. These patients were all under treatment during the period of observation, and in no case was additional trauma recorded while the patient was being followed. The paucity of cases and the slight degree of increased slipping of the affected vertebra would tend to indicate that there is not a marked tendency for the deformity to increase.

It is of unusual interest to report that 2 patients in the total number of cases, both of whom presented symptoms and roentgenographic evidence of typical spondylolisthesis of the fifth lumbar vertebra, have subsequently become married to each other. Two children have been born, and recent roentgenographic studies have been made of the lumbosacral spines of these children, both males. In the first child, now 17 years of age, an incomplete sacralization of the fifth lumbar vertebra is present. In the second child, now 12 years of age, there is evidence of spondylolysis of the fifth lumbar vertebra.

Since no disease process is known which is likely to produce a narrow transverse defect of one or both laminæ of a lumbar vertebra, and since pathologists have reported no surrounding soft tissue involvement, inflammation may be ruled out as the etiological factor in spondylolisthesis. Belief that the lesion is congenital in nature is favored by lack of evidence at the time of operative procedures or postmortem examinations of callus formation at the site of the defect. No one has presented a case of spondylolisthesis attributed to trauma in which previous roentgenograms were found to show a normal lumbosacral spine. The fact that unilateral cases exist (in 25 per cent of cases, according to Willis), and the striking uniformity of defects in each lamina are points against fracture as the etiological agent. The laminæ affected are themselves often defectively developed. The frequency of associated congenital defects in many patients in this series would further substantiate a developmental anomaly as the etiological basis.

INCIDENCE

Interarticular neural arch defects have been variously reported by different authors as follows: (1) Neugebauer reports arch defects in 5 per cent of spinal columns; (2) Willis, in 4.3 per cent of 748 American spines, in 5.2 per cent of 1,520 human skeletons, and in 6 per cent of cadavers; (3) Shore, in 9.1 per cent of 56 Bantu South African native skeletons; (4) Stewart, in 39 per cent of 187 spinal columns from Eskimos living north of the Yukon, and in 14.7 per cent of 225 spinal columns from Eskimos living in or south of the Yukon; (5) Mitchell, in 3 per cent of European skeletons; and (6) Congdon, in 5 per cent of 200 skeletons of American aborigines.

Bohart, in 1929, examined roentgenographically the spines of 931 employees of the Belt Railway Company in Chicago, in almost 50 per cent of whom spinal variations and anomalies obtained. Three of these individuals had spondylolisthesis. Herndon found 2 cases of spondylolisthesis in treating 941 consecutive cases of back injuries in industrial employees.

During the 4 year period from 1934 to 1937, 2,683 patients were examined at the New York Orthopædic Dispensary and Hospital who presented evidence of congenital deformity or mechanical instability of the lumbar spine. A further group of 503 patients presented evidence of other conditions involving the lumbar spine. During this 4 year period, 108 patients with spondylolisthesis and 7 patients with spondylolysis were examined, a total of 115 patients. This represents an incidence of 3.5 per cent in the group of 3,301 patients examined because of signs and symptoms referable to the lumbar spine. In comparison with other reported figures this incidence would suggest that interarticular neural arch defects occur in many individuals without producing symptoms.

PATHOLOGY

In spondylolisthesis the break in the osseous ring is always found between the articular facets, the inferior facets remaining attached to the laminæ. Thus the body of the affected vertebra with its superincumbent weight loses bone connection with the spinous and inferior articular processes that anchor the trunk to the pelvis. The defect may be unilateral but is usually bilateral (Fig. 1). In the slipping forward of the fifth lumbar vertebra only the anterior portion of the vertebra is affected, there being no real unlocking of the interarticular joints (Fig. 2). The soft tissues elongate and undergo pathological changes not unlike the response to strain in unreduced congenital dislocation of the hip where the capsule and muscles are stretched and thickened with weight bearing.

SYMPTOMS

Pain in the low back was practically the universal chief complaint that was encountered in this series of patients, with considerable variation in the intensity of the pain. However, 13 individuals were entirely free from pain, and in 10 instances the deformity was an incidental finding upon examination of the patient for other conditions. Weakness, fatigue, or stiffness in the low back, as opposed to definite severe pain, caused several patients to seek treatment. Low back pain, ranging from an occasional ache to constant, severe pain occurred in 255 patients. Thirty-six individuals localized their pain at the hip, 17 in the buttock, and 9 in the coccyx. Radiation of pain down the leg was present in 129 individuals, and confined to the distribution of the sciatic nerve in 27 of these patients. Ten individuals suffered pain in the foot down to the toes. Patients suffering from paraplegia associated with spondylolisthesis have been reported in the literature but were not found in this series. Duration of symptoms varied from 12 hours to 30 years. The average duration of symptoms was 50 months.

The clinical picture of the patient suffering from severe spondylolisthesis has been classically described by Turner and Tchirkin, with particular attention directed to the lumbar lordotic hollow, shortened trunk, prominent spinous process of the fifth lumbar vertebra, and fatty skin folds above the iliac crests.

Although several patients in the series presented complete anterior displacement, with the fifth lumbar vertebra rotated on a transverse axis so that its inferior surface rested upon the proximal portion of the anterior surface of the sacrum, the usual clinical picture was less clearly defined. Diminution in the anteroposterior diameter of the pelvic inlet has been especially noted by obstetricians.

In this series, 103 patients presented lumbar muscle spasm. One hundred and thirty-four were tender on pressure over the spinous process of the fifth lumbar vertebra. Increased lumbar lordosis was found in 92 instances, although in 30 others there was decreased lumbar lordosis, all confirmed by roentgenograms. In 42 patients the spinous process of the fifth lumbar vertebra and in 5 patients the spinous process of the fourth lumbar vertebra was prominent. In 2 cases there was a kyphosis of the lumbar spine. Spine flexion was limited by pain in 56 individuals. Forty-three were tender on pressure over the sacro-iliac region, 8 over the sacrum, and 7 over the coccyx. Thirty-five patients presented a list of the trunk, and 20 others had an associated scoliosis.

There were 175 males and 138 female patients in the series. The youngest patient was 2 years of age, and the oldest 76 years. The average age at first examination was 34 years. The average age at onset of symptoms was 30 years.

ROENTGENOGRAPHY

Interpretation of the roentgenographic examination of each patient in this series was made by Dr. Albert B. Ferguson, roentgenologist to the New York Orthopædic Dispensary and Hospital. In all cases it was a routine procedure to take a lateral picture of the lumbosacral region, one anteroposterior view, and another anteroposterior view at an angle of 45 degrees, the latter film showing the sacrum and sacroiliac joints better, and the relationship of the transverse processes of the last lumbar vertebra to the lateral masses of the sacrum.

Spondylolysis or spondylolisthesis was found in the second lumbar vertebra in 3 individuals, in the third lumbar vertebra in 6 patients, in the fourth lumbar vertebra in 35 instances, in the fifth lumbar vertebra in 267 individuals, and in the sixth lumbar vertebra in 2 cases. Complete failure of fusion of the laminæ to the pedicles was present in 257 patients. In 37 individuals asymmetry of the articular facets was also present, and increased obliquity of the articular facets was noted in 61 others. Arthritic lipping was found in 40 patients. In 40 instances there was proximity of the spinous processes of the affected vertebræ. Thinning of the intervertebral disc was present in 32 cases. In 156 patients the lumbosacral angle exceeded 40 degrees. Posterior sacral defects were noted in 45 patients.

In 6 patients the lesions of both spondylolisthesis and spondylolysis were found in different vertebræ. There were 6 cases of unilateral spondylolysis in which the neural arch defect was confined to one side, the opposite laminar development being normal.

DIFFERENTIAL DIAGNOSIS

Careful physical examination with proper roentgenographic study of the patient are the essential factors in establishing the diagnosis. In spondylolysis and in no other condition is there a characteristic defect in the lamina which is always localized to the interarticular portion of the posterior arch between the superior and inferior facets. In spondylolisthesis there is added a slipping forward of the vertebral body. Frequently there is an associated underdevelopment of the posterior vertebral arch. There is anteroposterior broadening of the sacrum in relation to the vertebral body of the fifth lumbar vertebra, when the lesion is located at the lumbosacral joint.

Fracture-dislocation at the lumbosacral joint is accompanied by either a dislocation of the facets, or fracture of the facets. The laminæ remain intact, the facets going forward with the body. There is usually evidence of callus formation at the site of the lesion. There is no evidence of developmental changes in anteroposterior diameter of the sacrum and fifth lumbar vertebral body. There is a separation of the spinous processes.

In Pott's disease an effusion, even though mild, is present. There is bone destruction, cavitating the vertebral body; there is usually a kyphos in the alinement of the spinous processes; there is no separation of the vertebral body forward from the arch unless there is great destruction, in which case there will be evidence of sequestration.

In Kuemmell's disease there is simple wedging of the vertebral body. No features of spondylolisthesis are present.

In osteomalacia there is wedging of the vertebral body. Often there is expansion of the intervertebral disc. The lesion is almost always multiple and no features of spondylolisthesis are present.

Malignancies do not tend to induce displacement or deformity of the vertebral body. The destruction cavitates the vertebral body and does not represent a pressure loss of substance.

Congenital dislocation of the hips and coxa vara may be ruled out by the condition of the hips in the absence of signs of spondylolisthesis in roentgenograms of the lumbar spine.

Interarticular neural arch defects or luxation of the vertebral body are usually not found in roentgenograms of the lumbosacral spine in those patients whose symptoms follow rupture of the nucleus pulposus of the intervertebral disc or hypertrophy of the ligamentum flavum.

OPERATION

By means of the spine fusion operation bony continuity is restored between the lumbar spine and the sacrum. Solid bony fusion precludes further anterior displacement of the affected vertebral body. The operation essentially extends the sacrum in a proximal direction. Fusion of the fifth lumbar vertebra alone to the sacrum, when the spondylolisthesis affects the fifth lumbar vertebra, is insufficient to restore bony continuity. Fusion from the fourth lumbar vertebra to the sacrum has been found practical in cases with spondylolisthesis of the fifth lumbar vertebra, and it is not essential to include the third lumbar vertebra in the fusion area as was done in several instances in this series. The third lumbar vertebra must be included in the

fusion area, however, when the spondylolisthesis is present at the fourth lumbar vertebra.

The indication for operation procedures is usually determined by the degree and duration of pain. In other words, when the pain becomes so severe that the sufferer demands relief not obtained by conservative methods of treatment, the operation is definitely indicated. Once the diagnosis has been established and there are no contra-indications to operation because of age or physical condition, the patient is advised to undergo the operative treatment. The giving of such advice has caused many patients in this series to seek other forms of treatment elsewhere before conservative methods of treatment, including physiotherapy and local support, could be instituted.

The first spine fusion in this series for spondylolisthesis was done on October 13, 1914, and the first fusion operation for spondylolysis was performed on March 28, 1928. One hundred and ten patients have been treated by the spine fusion operation, performed in each instance according to the technique first described by Dr. Russell A. Hibbs. One hundred and two of these patients had spondylolisthesis and eight had spondylolysis. Occasionally the spinous process of the third lumbar vertebra, or bone from the adjacent posterior superior iliac spine has been utilized as a source of additional bone chips for reinforcement. No bone graft or osteoperiosteal graft was used because multiple bone chips are considered preferable for the purposes of fusion. In one individual an osteoperiosteal graft inserted at another hospital had to be removed before fusion could be obtained. The duration of each operation ranged as a rule between one and one and one-half hours. A typical fusion mass is shown 8 months following operation for spondylolisthesis (Fig. 3).

Anterior approach to the lumbosacral region of the spine has been utilized in fusion operations for spondylolisthesis by Burns and by Mercer. Necessity of invading the peritoneal cavity plus possible hemorrhage from the lumbar veins which lie anterior to the lumbosacral area, to mention no further technical difficulties, are sufficient reasons for hesitancy in using the anterior approach method in the light of results as obtained by the spine fusion according to the technique of Hibbs performed through the posterior approach. No method has been found to assure reduction of the anterior luxation of the affected vertebra in this series. In several of the patients, plaster jackets were applied under traction in an effort to reduce the deformity but review of these cases fails to indicate any reduction of the anterior slip of the involved vertebral body.

The treatment following operation consisted of a period of recumbency in bed for 6 to 12 weeks, during which time a light steel spinal brace extending from the shoulders to the sacrum is worn. The length of time the patient wears the brace while ambulatory varied between 3 months and 1 year, depending upon the type of the individual patient and solidity of the fusion mass as judged from roentgenograms. The optimum period is now deemed to be 12 weeks of recumbency following operation as a minimum, with ambulatory wearing of the spinal brace for at least 6 months following the operation.

In this series there were no operative deaths. There were 3 infections, one of which was due to mixed Staphylococcus and Streptococcus infection, and 2 due to Staphylococcus alone. All 3 infections cleared up after incision and drainage of the operative wound, and all 3 patients demonstrated a solid fusion mass in roentgenograms subsequent to operation. In a few instances the meninges were opened unintentionally during operation, with no ill results to the patient.

Although 22, or 24 per cent, of the 91 patients included in the follow-up study of the operated cases developed a failure of fusion, or pseudoarthrosis, this apparently high incidence of pseudoarthrosis is not considered surprising in view of the very severe stresses and strains which beset the lumbar spine, and more especially the lumbosacral juncture.

FOLLOW-UP STUDY

Nineteen patients operated upon because of spondylolisthesis were followed after operation less than 1 year, and, therefore, are not included in the follow-up study. The efficacy

Fig. 1. Forty-five degree anteroposterior view showing bilateral interarticular defect in spondylolisthesis of the fifth lumbar vertebra in a male patient 15 years of age.

Fig. 2. Lateral roentgenogram of spondylolisthesis of the fifth lumbar vertebra present in a female patient 34 years of age.

of the spine fusion operation must, therefore, be judged from the results obtained in 83 patients with spondylolisthesis and 8 patients with spondylolysis, a total of 91 patients. One hundred and twelve fusion operations were performed upon these 91 patients, as 14 patients required secondary operations for repair of pseudoarthrosis. The shortest follow-up period included was 1 year. There is 1 patient who has been followed for 19 years. The average follow-up period for the 91 cases is 5 years.

Seventy-four patients, or 81.3 per cent of the cases in this group, were entirely relieved from pain by the operative procedure. Several of these patients have returned to work as laborer, bricklayer, painter, or machinist, which illustrates that it is possible for these individuals to resume former occupations. Thirteen patients, or 14.3 per cent, have been improved by the spine fusion operation, but were not entirely relieved from all low back pain. Several of these individuals complain only of an undue sense of fatigue in the low back area after long hours of work. In 7 of

Fig. 3. Lateral view of spine fusion mass extending from the fourth lumbar vertebra to the sacrum. Same patient as shown in Figure 2.

the group roentgenographic examination indicates the presence of pseudoarthrosis in the spine fusion mass, but further operative measures have been denied by the patient. No patient in this class is suffering from pain as intense as that present before operation, and all have secured more than 50 per cent improvement in relief of their pre-operative pain.

Four patients, or 4.4 per cent of the 91 patients in the follow-up study, have not been improved by the spine fusion operation. One of these patients showed no fusion present 5 years after the spine fusion operation. At that time a refusion operation was performed in another hospital, following which the patient died with urinary suppression due to a chronic nephritis. In the other 3 patients there was roentgenographic evidence of pseudoarthrosis in the spine fusion area. A refusion operation was therefore indicated, and was performed in another hospital in 1 instance. Permission for refusion has been withheld in the second patient, and is contra-indicated in the third patient who suffers from a severe cardiac lesion.

The ability to secure solid bony fusion in the spine fusion mass varies individually due to factors which are obscure at the present time. Ten patients underwent refusion before securing solid bony union. Three other patients had 2 refusion operations performed before solid fusion was present. In 1 other patient it was necessary to perform 3 refusion operations. Co-operation of the patient is considered to be of uppermost importance. The best of nursing care, with gentleness in turning the patient while in bed, is a prime requisite. A well balanced diet, adequate in vitamins, is also thought important. These patients are encouraged to increase their consumption of milk following the spine fusion operation.

CONSERVATIVE TREATMENT

Many patients in this series feared and refused operative measures to secure relief from their symptoms, or were considered poor candidates for the spine fusion operation because of advanced age or physical condition. Frequently physiotherapy, in the form of local heat and massage to the lumbosacral region, postural exercises to reduce lumbar lordosis, a firm bed, and support to the lumbosacral spine with a belt or corset, will afford symptomatic relief to these patients. Fifty of these individuals have been followed from 1 to 18 years. Thirty-one, or 62 per cent of these patients, have had no improvement in their condition from the conservative methods of therapy. Ten, or 20 per cent of these individuals, have been relieved somewhat by conservative treatment, and only 9, or 18 per cent, have been entirely relieved from recurrence of their symptoms.

SUMMARY

1. Two hundred and seventy-one patients with spondylolisthesis and 42 patients with spondylolysis, a total of 313 cases, are reported.

2. A follow-up study of 91 patients who underwent spine fusion operations, after the technique of Hibbs, between October 13, 1914, and February 12, 1937, is reported.

3. There were 175 male and 138 female patients in the series.

4. The age at the time of examination varied between 2 and 76 years of age, the average being 34 years.

5. There was no operative death in the series.

6. There were 22 patients, or 24 per cent, who developed failure of fusion, or pseudoarthrosis, many of whom were relieved by repair of the pseudoarthrosis at a second operation.

7. Thirty-one patients, or 62 per cent of 50 individuals studied, failed to obtain relief from conservative methods of treatment.

8. Seventy-four patients, or 81 per cent of 91 individuals receiving the operative treatment, were completely relieved of symptoms.

9. In spondylolisthesis or spondylolysis a spine fusion operation is considered to be the method of treatment best calculated to give permanent relief from symptoms, and to be fully justified by the results obtained in this series of cases.

10. Evidence is presented which tends to confirm the theory that the lesion in spondylolisthesis and spondylolysis is essentially a

congenital developmental defect in the interarticular portion of the laminæ of the involved vertebra rather than the result of trauma.

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CLINICAL SURGERY

FROM THE KING'S COLLEGE HOSPITAL

TRACHEOTOMY

TERENCE CAWTHORNE, F.R.C.S., London, England

TRACHEOTOMY consists in making an opening into the trachea below the larynx; and to be successful the opening must be below the obstruction that makes the operation necessary, and it must be maintained free from subsequent obstruction.

The operation is simple provided that it can be done without undue haste and in good surgical surroundings. Moreover, any possible dangers are easily avoided by obeying the few, well defined rules that will be described later, and no complications are likely to follow a good operation that receives proper attention afterward. It should be the aim of every doctor who has to deal with a case of laryngeal obstruction requiring tracheotomy to plan the operation so that it may be carried out in a deliberate, orderly, and unhurried manner. If, however, laryngeal obstruction develops rapidly, or if medical advice is not sought until the obstruction is in an advanced stage, a hurried operation in unfavorable surroundings may be essential if life is to be saved.

It is the purpose of this article to describe the deliberate operation step by step, not only because this is the method of choice, but also because a thorough appreciation of the planned operation will aid the surgeon when circumstances demand the hurried operation as a life saving measure.

INDICATIONS

Tracheotomy is required when obstruction at or about the larynx so diminishes the respiratory exchange that it is insufficient for the needs of the body when at rest. Tracheotomy may also be required as a preliminary stage in certain operations on the air passages. Finally, it has been recommended recently in certain cases of tracheobronchial suppuration.

Laryngeal obstruction may be produced by a variety of causes, but as the most urgent consideration is to relieve the condition, it will be better to consider in detail the prominent features of laryngeal obstruction rather than to enumerate a list of conditions that may cause it.

The picture produced by laryngeal obstruction depends largely upon the time which such an obstruction takes to develop. When the onset is sudden and the rate of increase fast, the symptoms, signs, and the remedy required are only too obvious, even to the lay eye. When the obstruction increases slowly, the significance of the panorama that gradually unfolds itself may not always be appreciated in the early stages; or if it is, surgical relief may be withheld in the vain hope of a spontaneous cure.

Respiratory system. Audible respiration is the most obvious sign of laryngeal obstruction and is present in every case. The pitch and amplitude of the sound may depend to a certain extent upon the age and sex of the patient and upon the degree of obstruction. The timbre of the sound, however, is constant in all cases. It can be produced by anyone at will by making a forced inspiration with the glottis nearly closed. It is usually described as *crowing*, and must be distinguished from obstruction in the lower part of the tracheobronchial tree, in which the noise is a *wheeze*, usually more noticeable on expiration. This is rather an important point, because the writer has been asked on more than one occasion to perform a tracheotomy on a patient with obstruction in the lower part of the trachea. Had the referring physician trained his ear to recognize the difference between a crow and a wheeze, he would have realized that the obstruction could not be relieved by tracheotomy.

At the onset of laryngeal obstruction audible respiration may not be noticed when the breathing is quiet and shallow. Anything that may increase the rate or extent of the respiratory exchange will tend to initiate or augment audible respiration. This accounts for the phenomenon not infrequently seen in children, where a fit of struggling for breath and rapid and exaggerated respiratory efforts are succeeded by exhaustion in which the quiet and shallow respiratory movements cause the audible respiration to disappear. In brief, every case of audible respiration should

be considered as a potential candidate for tracheotomy. For the large majority of these cases tracheotomy will not be necessary, but an attitude of preparedness will go far to avoid the tragedies resulting from the neglect of one of nature's greatest danger signals.

The bringing into action of the accessory muscles of respiration in conjunction with other signs indicate laryngeal obstruction. In this connection it is worth while mentioning the significance of the alternate periods of quiet sleeping and choking fits with waking that are so characteristic of increasing obstruction. While the patient is conscious the voluntary or accessory muscles of respiration are brought into use, but as the patient falls asleep the voluntary muscles stop working. This may not be noticed for some seconds or minutes, but gradually diminished air entry calls for deeper respiration and this causes choking and the patient awakes.

The soft tissues which clothe the thoracic cage may be indrawn on each inspiration. This can be seen at the suprasternal notch, in the supraclavicular region, and between the ribs. It should always be sought for, and the degree and extent of the indrawing is a rough index of the severity of the laryngeal obstruction. On inspiration the rush of air acts on the soft tissues surrounding the upper margins of the larynx and draws them in, thus further narrowing the already restricted airway. It is this mechanism which accounts for the increased distress that is noticed with forcible inspiration and is such a marked feature of the complaint in children. When the laryngeal obstruction is very gradual in its onset and extremely slow in its progress, such as in the case of a neoplasm, the patient learns to economize in respiratory movements and may reach a very high degree of tolerance to the obstruction, so that life is possible with an airway that would have been totally inadequate if the onset of the condition had been rapid.

In the terminal stages of laryngeal obstruction the respiratory mechanism is likely to show signs of exhaustion, and the respiratory movements become more gentle until at last they quietly cease forever.

Cardiovascular system. In advanced stages of respiratory obstruction diminished oxygenation of the blood will result in cyanosis, and the degree in which this is reflected in the skin depends upon several factors. In those cases in which there is a good peripheral circulation and a normally fresh color, cyanosis will be obvious. In the normally pale, or in those in whom the heart is already enfeebled by disease, cyanosis may be absent and there may only be increasing pallor with a slightly leaden or mauve tinge to indicate the true state of affairs. This is especially noticeable in the most dangerous type of case under consideration, diphtheritic laryngeal obstruction in childhood in which the already enfeebled heart is handicapped by a tremendous increase in work. This results in pallor due to the poor peripheral circulation and such pallor may only give way to cyanosis in the ultimate stages of the complaint. In other words, cyanosis may be obvious only as a terminal event and should not be waited for before advising tracheotomy. What is not generally realized is the tremendous increase in work that the heart is called upon to do in cases of respiratory obstruction. In small children, in the presence of audible respiration, it is very strongly felt that one of the most urgent reasons for tracheotomy is an increasing pulse rate and signs of dilatation of the right side of the heart.

PRE-OPERATIVE PREPARATION

Tracheotomy does not call for any special pre-operative measures apart from ensuring that the necessary equipment is at hand and in good working order. This is a very necessary pre-operative precaution because tracheotomy is a relatively infrequent operation, and unless periodically overhauled the instruments have a way of getting mislaid. Whenever time will permit, steps should be taken to provide proper postoperative care, because the ultimate success of the operation depends so much upon this.

The method that will be described is employed in the clinic at King's College Hospital whenever the condition of the patient will permit. The operation need not take more than 10 minutes and is always employed when the patient has sufficient airway to enable him to be removed to a properly equipped operating theater. Sometimes the need for relief of laryngeal obstruction is so urgent that more rapid methods must be employed, possibly in unfavorable surroundings without all the equipment and assistance that may seem necessary. Then the method employed to relieve the obstruction will depend upon the resources available and no definite rule can be laid down as to exact procedure. If, however, the cardial features of the more deliberate operation can be committed to memory, the undoubted difficulties of the life saving emergency tracheotomy will be minimized. The strain of a hurried, and of necessity unsurgical, operation is so great both on the patient and the surgeon that no effort should be spared to bring a patient to operation in time to avoid this.

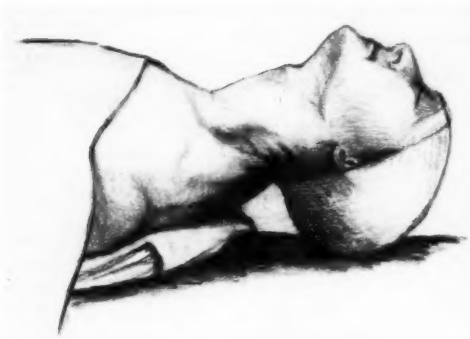

Fig. 1. A folded towel which is placed under the shoulders extends the neck so that the trachea is brought nearer to the surface.

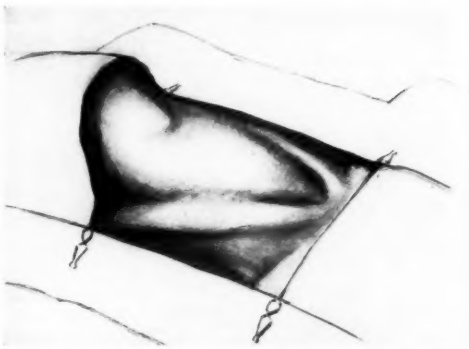

Fig. 2. The field of operation showing the principal landmarks: the thyroid cartilage above, the suprasternal notch below, and the sternomastoid muscles on either side.

Anesthetic. Any form of general anesthetic, however skilfully administered, is bound to aggravate laryngeal obstruction. The possible advantage of unconsciousness to the patient is far outweighed by the danger of increasing any pre-existing obstruction to the airway, and for this reason a general anesthetic cannot be recommended.

Subcutaneous infiltration of the operative areas with 1 per cent novocain not only renders the operation painless but also diminishes the tendency to bleeding. This form of anesthesia should always be employed when time will allow. Urgent dyspnea or infection in the tissues overlying the trachea may require operation without any form of anesthesia at all.

Position. The patient should be lying on his back with a sandbag or folded towel underneath the shoulders so as to extend the neck and thus bring the trachea nearer to the surface. The head should be extended on the neck, and it must be kept strictly in the midline so that the nose, chin, and suprasternal notch are in one line. Any deviation from this midline position will alter the normal relationships of the trachea and add to the difficulties of the operation. This is so important that an assistant can be well employed in steadying the head and seeing that it is kept in the midline. It sometimes happens that the prone position with extended neck makes a partial laryngeal obstruction complete. Then in order to operate in an orderly unhurried manner it may be necessary to work with the patient sitting up. This is not easy and should be considered only in the non-urgent cases of obstruction where speed is not essential.

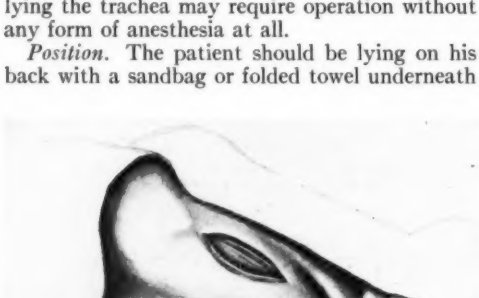

Fig. 3. The incision has exposed the pretracheal muscles, and the line of separation between the muscles of the two sides can be seen in the center.

Infiltration. The skin and subcutaneous tissues in the midline of the neck are infiltrated with 1 per cent novocain from the thyroid cartilage to the suprasternal notch. A band of infiltration one inch wide is required, and can usually be obtained with 20 or 30 cubic centimeters of fluid; as much as 100 cubic centimeters may be used without any danger.

OPERATION

Incision. The surgeon stands on the right side of the patient, and the principal assistant on the left. The mobile larynx and skin are fixed by the thumb and middle finger of the left hand. This is of special importance in children in whom the larynx is very mobile and is one of the essential steps of the emergency operation. The incision should extend vertically downward from the cricoid cartilage for at least 3 inches and must be

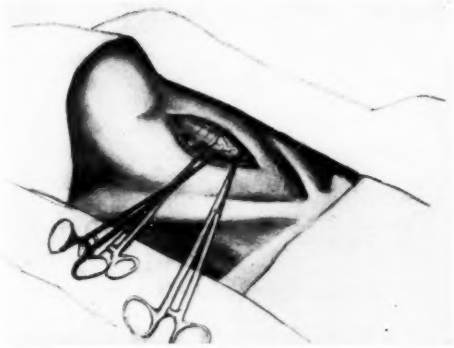

Fig. 4. The trachea has been exposed, and the isthmus of the thyroid gland is shown covering the third and fourth tracheal rings.

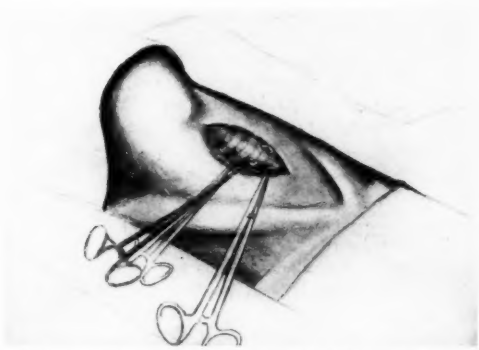

Fig. 5. The unimportant thyroid isthmus has been divided between ligatures so as to give better exposure of the trachea.

strictly in the midline. The only exception to this rule is when the tracheotomy is required as a preliminary to a pharyngeal or laryngeal operation. In such a case an oblique or transverse incision 1 or 2 fingers' breadth below the cricoid cartilage may be used.

The incision should extend through the skin and down to the deep cervical fascia in its whole length. Any bleeding points are secured by artery forceps that may conveniently be curved so that they lie flat on the neck and act or be used as retractors. In the hurried operation the incision must go deeper than this, preferably down to the trachea, and bleeding is to be ignored.

Exposure of the trachea. The deep fascia is incised, again strictly in the midline, when the division between the 2 sets of pretracheal muscles may be seen. Careful separation is important here, especially in children, because it is very easy to deviate from the midline, especially to the left. Loose cellular tissue will be found here, particularly in the lower part of the wound, and then another sheet of fascia comes into view. At this stage the position of the trachea may be confirmed by palpation with the left index finger. In the emergency operation directly after the deep incision the left index finger will be employed in feeling for the tracheal rings and continuing any essential blunt dissection. It must be remembered, however, that in very young children the cartilaginous rings of the trachea may be deceptively soft. Under this second sheet of fascia lies the trachea in the uppermost part of the wound. A little farther down is the isthmus of the thyroid gland. The isthmus usually lies over the third and fourth tracheal rings and may easily be retracted downward. If unusually high or difficult to retract, the isthmus should be divided between forceps without hesitation, as it is only of anatomical importance. If special angular clamps are used on the isthmus they may, after it has been divided, be rotated outward, thus bringing the trachea more to the surface. Incision of the investing tracheal fascia reveals the tracheal rings.

Intratracheal injection. At this stage, if time permits, it will be advantageous to insert the needle of a hypodermic syringe charged with 10 per cent cocaine between 2 tracheal rings and to inject a few millimeters of the cocaine solution into the tracheal lumen. This serves to lessen the spasm of coughing that would otherwise occur when the trachea is opened, and makes for what its originator, Sir St. Clair Thomson, describes as tranquil tracheotomy.

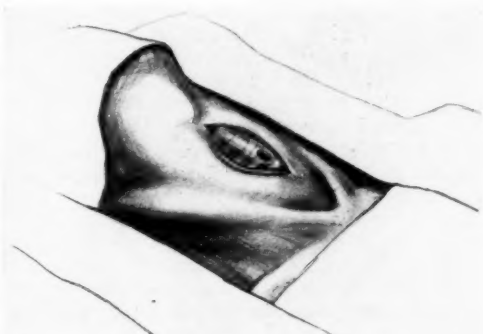

Fig. 6. A disk has been cut out of the anterior tracheal wall just sufficiently large to admit the tracheotomy cannula.

Hemostasis. At this stage all bleeding points should be ligatured and artery forceps removed. It is important not to trust to the temporary pressure of the artery forceps to arrest hemorrhage, because it not infrequently happens that unligatured vessels may start to bleed after the vasoconstrictor effect of the local anesthetic has worn off. In the hurried operation both this and the preceding stages will be omitted, and bleeding can be dealt with after the trachea is opened.

Opening the trachea. The site of election is through the third and fourth tracheal rings. In no circumstances should the cricoid cartilage or first ring of the trachea be cut across, for fear of subsequent laryngeal stenosis. Insufficient attention is paid to this essential point in many of the descriptions appearing in textbooks, and possibly only those who have the unenviable task of trying to cure laryngeal stenosis realize how important it is to maintain the integrity of the cricoid cartilage and uppermost tracheal ring.

In small children in whom the trachea is very mobile it may be advisable to steady the trachea by inserting a sharp hook into or just below the cricoid cartilage and having this held by an assistant. At this stage the end-piece of a suction apparatus should be held near the trachea so the tracheal opening may be kept free from secretion and blood prevented from entering the trachea.

With a fine bladed scalpel a short transverse incision is made to one side of the center of the front wall of the trachea between the third and fourth tracheal rings. Into this incision is inserted one blade of a pair of fine toothed forceps. The tracheal wall is grasped by the forceps and one blade of a pair of fine, fully curved scissors is inserted and a small disc of the anterior tracheal wall cut away. This disc should be the same size as the diameter of the tracheotomy tube, so that when the tube is in position it will fit tightly and prevent any escape of tracheal secretion or air into the wound. During this maneuver care must be taken so that the posterior tracheal wall is not injured, because the violent expiratory effects that may accompany the opening of the trachea, especially if cocaine has not been previously injected, will bring the posterior wall forward so that it may almost bulge into the tracheal opening. Even worse than this would be perforation of the posterior tracheal wall and injury of the esophagus. This might happen if the scalpel were indiscriminately plunged into the trachea. The possibility of this occurring can be prevented by so holding the scalpel that only a quarter of an inch projects beyond the end of the index finger.

An alternative method is to incise vertically the third and fourth tracheal rings in the midline and then to insert a pair of dilating forceps. This will be the procedure in hurried cases, but if speed is not essential the careful removal of a small disk of tracheal wall is preferred. It makes introduction and removal of the cannula easier and in the event of the outer cannula being accidentally displaced, retraction of the edges of the wound will enable the patient to breathe until skilled help is available to replace the tube.

Insertion of the tracheotomy tube. The tracheotomy tube is now inserted with its pilot, which is withdrawn when the tube is in position, and the inner tube is inserted. Prior to this one-fourth inch linen tape has been threaded on to the wings of the tube. The inner 2 inches of each tape is guarded by a piece of rubber tubing which prevents the tape from cutting into the sides of the wound. In emergency cases artificial respiration and stimulants may be required at this stage. The bleeding, also that had been ignored previously, will not have to be stopped, although the opening of the trachea will have done much to lessen it.

Dressing. While the tube is held in position by an assistant the wound is lightly packed with 2 inch ribbon gauze impregnated with iodoform. Under no circumstances should the part of the wound below the cannula be sutured for fear of surgical emphysema or spreading sepsis. Two squares of gauze are placed over the dressing, one above and one below the tube, and the tapes are tied around the neck over this.

The skin below the wound may be smeared with soft paraffin to prevent irritation from secretion. Over all this is placed a veil of oiled silk with a hole in the center through which the tube projects. This helps to keep the dressing from being unduly soiled by tracheal secretion.

Acapnia. Before the patient leaves the theater a final inspection should be made to ensure that there are no bleeding points and a note should be made of the respiration. Numerous fatalities have been recorded from time to time that occurred shortly after the trachea was opened. These have often been in cases of long standing laryngeal obstruction, and it has been shown by Negus that they are due to acapnia. During the period of laryngeal obstruction there has been a steady increase in the carbon dioxide content of the alveolar air and also in the carbon dioxide content of the blood. Sudden removal of the obstruction results in this excess of carbon dioxide suddenly being reduced. The respiratory center has been accustomed to an increased carbon

dioxide stimulus, and when this is suddenly removed it refuses to respond. Unless carbon dioxide is available the patient may die from acapnia. Therefore, provision should be made in the operating theater and at the patient's bedside for a carbon dioxide-oxygen mixture to be available if required.

POSTOPERATIVE CARE

The relief of laryngeal obstruction by the provision of an alternative airway does not mean that medical supervision can be relaxed. On the contrary, it initiates an entirely fresh set of therapeutic problems that require careful and constant attention if a successful outcome is to be attained. The problems that are the immediate concern of those responsible for the aftercare are: (1) the maintenance of a free airway; (2) the accommodation of the patient to the altered conditions of his respiratory mechanism; and (3) the neutralizing of the ill effects produced by prolonged obstruction on the lower respiratory tract. In order that these problems may receive the attention they require, constant nursing supervision is necessary and certain special equipment must be available at the bedside. It will be convenient here to give separate descriptions of the more important factors concerned.

Bedside equipment. It has already been mentioned that a cylinder of carbon dioxide and oxygen should be at hand. A trolley should contain sterile duplicate cannulæ, retractors, a tracheal dilator, inner tubes, lotion, cleaning material for removal of secretion from inner tubes before boiling, a suction apparatus with two or more fine rubber catheters ready to be attached, and sterile dressings. These are the essentials that should be at the bedside of every tracheotomy patient.

Free airway. Constant attention is necessary for this. Secretion must be removed from the tracheal tube either by mopping or by suction. Any audible respiration means that some part of the respiratory tract is obstructed, and it may be helpful to pass a catheter down into the trachea and connect it to the suction apparatus. This may save the patient much laborious coughing. It will probably be necessary to remove the inner tube frequently for cleaning, and this should be instantly replaced by a spare inner tube, the soiled one being cleaned before boiling. It cannot be too firmly impressed upon the nurse in charge of the case that her main duty is to see that instant attention be given to any signs of obstruction, i.e., audible respiration or rapidly increased respiratory movements. Should the outer cannula become dislodged, she should remove all dressings, retract the wound edges, and wait for skilled help if she cannot easily replace the outer cannula herself. Central heating may reduce the humidity of the air, so that steps should be taken to remedy this. Care must be taken, however, not to overdo this, as it is felt that overuse of the steam kettle may do as much harm as it does good.

Accommodation to altered mechanism. It is always advisable to protect the patient from rapid changes of the temperature of the inspired air by means of a tent or screen around the head of the bed. One of the most important reasons for constant supervision during the first few hours after the operation is that the patient is deprived of his voice and is unable to call for assistance. Some slight difficulty in swallowing may sometimes be experienced, but encouragement with sips of water will usually overcome this. Excessive coughing may cause some distress, as the alteration of the normal coughing mechanism may make the bringing up of tenacious secretion a laborious matter. This can to a certain extent be overcome by using a suction apparatus to aspirate tenacious secretion from the trachea.

Lower respiratory tract. The removal of retained secretion can be assisted by the suction pump, in the way just described. At this stage it is wiser not to give any sedative that might in any way obtund the cough reflex. In order to assist expansion of the lungs the patient should be sat upright and encouraged to move from side to side so as to prevent stagnation at the bases of the lungs. An additional help in this direction will be the administration of the carbon dioxide-oxygen mixture for a few minutes every hour. When the secretion is very thick and tenacious the administration of alkalis may help to loosen it. Cases of laryngotracheobronchitis in which there may be a tendency to form crusts within the trachea and bronchi must be watched carefully. Increased respiration rate, distress, and on examination of the chest little or no expansion and air entry indicate blocking of a main bronchus with a plug. This calls for bronchoscopy which in severe cases may have to be repeated frequently.

Dressing. This will require frequent changing during the first day or two. The gauze squares should be changed whenever they are soiled, while the iodoform gauze packing in the wound should be changed at least once, if not twice, every 24 hours. It is rarely necessary to change the gauze more often than this and if the surrounding skin is kept protected by sterile soft paraffin no irrita-

tion from being constantly bathed in secretion should occur.

At every change of dressing the opportunity should be taken to examine the wound for any suggestion of spreading sepsis or surgical emphysema. All assistants should be warned not to use gauze with loose threads and never to use wool, because these can easily be inspired into the tracheobronchial tree. The same thing applies to blankets, which should not be allowed near the tracheotomy tube for fear that fluff from them may be inspired.

General. Treatment will naturally be directed toward the cure of the laryngeal obstruction, but is beyond the scope of this article. Adequate nourishment is essential and a large fluid intake must be encouraged.

When the cardiovascular system has been subjected to strain, small but regular doses of brandy should be given or more severe cases may require some form of digitalis or one of the more powerful cardiac stimulants such as coramine.

As soon as the general condition of the patient will permit, he should be encouraged to move from his bed. This will help to exercise the lungs.

Decannulation. This must be a gradual process. As soon as the patient can breathe comfortably with a finger over the tracheotomy tube it should be half corked. When the patient can sleep comfortably with this, the half cork can be replaced by a complete cork. Comfortable sleep with the tube completely corked is the indication for decannulation.

The return to laryngeal breathing may, at first, cause slight dyspnea, especially in children. If decannulation is too rapid, the dyspnea may result in panic, exaggerated respiratory efforts, and an increase in the dyspnea possibly sufficient to call for recannulation. Once this has happened the child will lose confidence, and further decannulation may be quite difficult.

Recannulation. This small maneuver has been the cause of so much trouble that it deserves a paragraph to itself. During the first few days after a tracheotomy it is not as a rule necessary to change the outer tube. Should it become necessary it must be done by the surgeon or a skilled assistant.

It is in the cases that have been decannulated too soon that the chief difficulties arise. It may be some hours after decannulation before the necessity for re-inserting a tube is apparent. Unless a disk had been cut from the trachea at the time of operation this may be difficult. In any case it should not be attempted without a good light, dilating forceps and, if available, a suction pump. It will simplify matters if the wound is packed for a few moments with gauze wrung out of 2½ per cent cocaine. This procedure is given special mention because the writer has found that the re-introduction of a tracheotomy tube some time after it had been removed has often caused considerable trouble, especially to those who approach the problem overconfident and not prepared.

SUMMARY

1. Tracheotomy is required to relieve increasing laryngeal obstruction and should not be postponed until the urgency of the symptoms demand a hurried operation.

2. General anesthesia increases the danger of the operation. Local infiltration renders the operation painless and reduces bleeding.

3. The midline position, a midline incision, and midline dissection will expose the trachea and avoid other important structures. Deviation from this midline rule is the commonest cause of operative difficulties.

4. The trachea must never be incised above the second ring, but preferably through the third and fourth. This will avoid the possibility of subsequent laryngeal stenosis, a permanent tube, and loss of voice for life.

5. The intratracheal injection of a few millimeters of cocaine and the excision of a disk of tracheal wall instead of the usual vertical slit are modifications of the traditional technique that make the operation more tranquil and the after treatment more simple.

6. Carbon dioxide should be at hand both in the operating theater and at the bedside in case acapnia should develop. This applies especially to cases of long standing laryngeal obstruction.

7. After care demands constant nursing attention and is directed toward keeping the airway clear, adjusting the respiratory mechanism to altered conditions, and combating the effects of laryngeal obstruction on the lower respiratory tract.

8. Decannulation should be gradual and should not be attempted until the patient can sleep comfortably with the tube completely corked.

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A NEW ASEPTIC DOUBLE-VALVED TUBOGASTROSTOMY

JACOB A. GLASSMAN, M.D., Chicago, Illinois

THE writer introduces a new, simple, and improved method of gastrostomy which is accomplished by a technique that is aseptic throughout.[1] This technique was developed to replace the long and complicated procedures employed today, in which excessive clamping, ligating, cutting, and sewing as well as exposure of the peritoneal cavity to contaminating substances from the gastric content, are objectionable features.

STAGES IN THE EVOLUTION OF GASTROSTOMY

Here a few remarks may be devoted to those stages in the evolution of gastrostomy which lead to the writer's new step. In 1893, Ssabanejew devised a method of gastrostomy in which a cone of stomach was formed by traction upward with an Allis forceps and brought out to the exterior. A second smaller incision was then made nearby through the skin and subcutaneous layer, and the cone carried to it by tunneling through the subcutaneous tissue between the 2 incisions. The apex of the cone after being brought through the second skin incision and attached to its edges, is then opened.

In 1896, Senn described a circular valve method. Purse-string sutures were placed at the base of a cone of stomach wall to fix it in place. An incision was then made into the apex of the conical structure, its free edges inverted, and the resulting fold fixed by sewing its rim, thereby creating a circular valve projecting inward toward the lumen of the stomach.

In 1896, Fontan described a valvular gastrostomy which he produced by elevating a conical diverticulum from the stomach by traction with a forceps, fixing its crown to the abdominal incision, invaginating the apex, and puncturing it. It is seen that it resembles the method devised independently by Senn in the same year.

In 1913, Janeway and Depage, working independently of each other, developed a flap from the anterior wall of the stomach, consisting of all layers, which was converted into a tube, lined with gastric mucosa, one end of this tube representing the opening into the stomach, and the other end the mouth to the exterior. Depage acknowledged Janeway's work, but it is established that priority really belongs to Depage. This method of gastrostomy proved to be inefficient because of the absence of a valvular structure.

In 1929, Spivack greatly advanced the surgery of gastrostomy by combining the tube formation of Depage and Janeway and his own method of forming a valve by invaginating all layers of the stomach wall, thereby evolving a very useful and efficient tubovalvular gastrostomy. Later McNealy and Thorek contributed to Spivack's operation by attempting to seal off possible points of leakage with omentum and falciform ligament.

DOUBLE-VALVED TUBOGASTROSTOMY

The great mortality rate following present day methods of gastrostomy is readily explained. Patients who require gastrostomy are those afflicted with esophageal obstruction of a benign or malignant nature. Pathological conditions of this sort weaken the patient to such an extent that by the time an operation is advised and accepted, marked emaciation has already set in, primarily because of the prolonged period of starvation. Obviously, such persons, who in most instances are past middle age, cannot tolerate any abdominal operation of long duration. The contamination of the peritoneum and the severe shock of surgical manipulation weaken the subject, so that death is a common sequel. It is estimated from the writer's gastrostomies on a series of dogs and on human patients that the duration of his method is diminished from approximately 1 to 1½ hours, which is the time required for the present day improved, but more intricate, gastrostomy, to about 20 to 30 minutes, thereby greatly reducing the mortality rate.

The method here described furnishes a double valve of excellent function and in the cases in which it was tried has remained competent throughout the period of observation that has extended over months. Through a left upper paramedian incision the stomach is exposed, and as illustrated in Figure 1, A, the anterior wall of the stomach is grasped with an Allis forceps at

Read before the chapter of Sigma Xi, University of Illinois, College of Medicine, March 30, 1938.

[1] The technique herein described was developed and perfected in the Department of Anatomy of the University of Illinois, College of Medicine, with the aid of Dr. Otto F. Kampmeier, professor of anatomy and head of the department. To him as well as to Dr. Yngve Joranson, Dr. W. H. Cole, Dr. M. Davison, and Dr. L. Aries the writer is greatly indebted for their invaluable help.

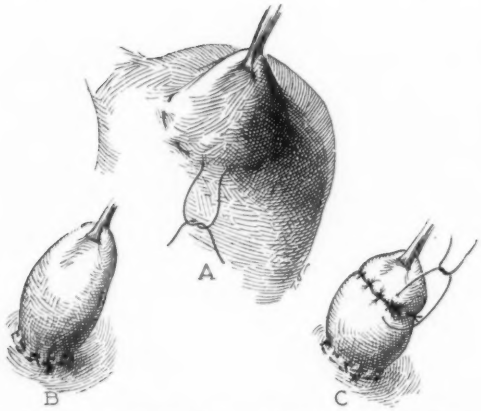

Fig. 1. A, Formation of a cone-shaped diverticulum from the anterior wall of stomach by traction. B, Fixation of the formed diverticulum by 2 basal purse-string sutures. C, Insertion of the third purse-string suture approximately midway between the basal sutures and the apex of the diverticulum.

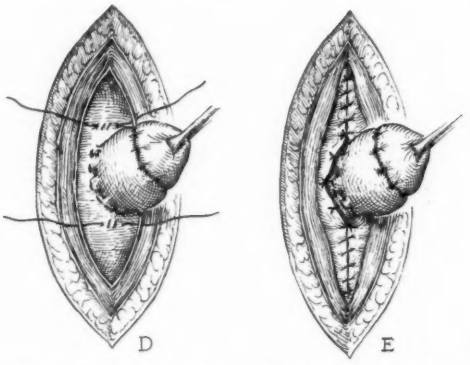

Fig. 2. D, Anchoring of the anterior stomach wall to the peritoneum and posterior rectus sheath by means of the desired over-and-over seromuscular stitch. E, The diverticulum protruding through the opening allowed during the closure of the peritoneum and posterior rectus sheath. More interrupted silk sutures are shown anchoring the lateral sides of the base of the diverticulum to the peritoneum.

the most mobile point, which is usually midway between the fundus and the pyloric antrum and equidistant from the greater and lesser curvatures. With the application of traction at this point a portion of the anterior wall is converted into a cone-shaped diverticulum. A purse-string suture of braided silk is then introduced into the seromuscular layer at the base of the diverticulum (Fig. 1, B), and with each stitch the tissue at the base is puckered until upon completion of this purse-string suture, the lumen at the baseh as been almost but not completely constricted. A second purse-string suture is then applied in the same fashion as the first, about ¼ inch proximal to the first suture. The ends of these 2 sutures are employed for traction when the Allis forceps at the apex is removed. A third purse-string suture is then introduced around the diverticulum midway between the apex and base to create a second valve more peripherally placed. Both valves are then reinforced by applying interrupted Lembert stitches of braided silk in the seromuscular layer at right angles to the purse-string suture (Figs. 1, 2, C, D, E). At this point the diverticulum, which has been constricted at two levels, usually presents a cyanotic hue, but in spite of the disturbance of circulation thus produced, no sloughing was noted in a series of 20 experimental animals. Traction on the diverticulum is still kept upward by the assistant. Interrupted seromuscular sutures are inserted in the anterior wall of the stomach at points superior, inferior, and lateral to the base of the tubal projection in order to fix the stomach wall to the peritoneum and to the posterior rectus sheath. It is very important that the sutures be embedded repeatedly in the seromuscular layer of the stomach wall before they are tied, since a single stitch may tear through the seromuscular layer. The

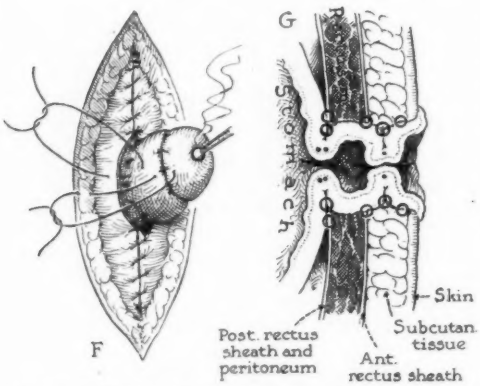

Fig. 3. F, Two untied sutures shown, the lower one representing the suture that attaches the tube to the anterior rectus sheath, and the upper one, the suture employed further to anchor the tube to the subcutaneous tissue. The cautery applied to the apex is the final step of the operative procedure. G, Diagrammatic cross section illustrating the arrangement of the initial or basal valve to the more peripheral valve. The circles represent suture-ties employed throughout the operative procedure.

tube itself is attached to the anterior rectus sheath and subcutaneous tissue as the various layers are reconstructed.

An opening into the apex of the tube by means of cautery may be made at any time from the first to the seventh day after the completion of the operation. It was found more desirable to delay the opening until near the seventh day, depending upon the patient's ability to swallow liquids, since a greater time is allotted for adhesions to form without any disturbance from external sources. This step is the culmination of an operative procedure which was achieved with entire asepsis, that is, without opening the stomach in the presence of peritoneal exposure, and without clamping, ligating, or cutting.

In G of Figure 3 a diagrammatic cross-section illustrates the arrangement of the initial or basal valve to the more peripheral valve. The circles therein represent suture ties, at points previously referred to, in anchoring the stomach and tube to the various abdominal layers.

By employing a technique similar to that described, an aseptic tubovalvular cystostomy is made possible.

The writer, in working out the details of the operation, recognized some modifications in technique which may or may not be advisable in particular cases. For example, in certain cases in which ample mobilization and additional stomach wall is required to establish the tubovalvular formation, partial detachment of the hepatogastric, or of the gastrocolic ligaments is undertaken.

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THE SURGICAL TREATMENT OF SPASTIC PARALYSIS

CLARENCE H. HEYMAN, M.D., F.A.C.S., Cleveland, Ohio

THIS study is based on the results of 280 operations upon 176 patients with cerebral spastic paralysis. All of the operations performed upon the upper extremity were in cases of hemiplegia. Spastic contracture or rigidity at the upper extremity is rarely present in diplegia where the disturbance in function is rather the result of loss of muscle control, athetosis, mass reaction, and inco-ordination.

Only a relatively small number of patients with spastic paralysis are amenable to surgical treatment. While no accurate figures are available, it is estimated that the 176 patients operated upon were selected from approximately 1,500 cases. Treatment in the majority of patients, should consist only of education, muscle training, occupational therapy, prevention of deformity, and correction of mild contractures by muscle stretching and educational methods. However, there are frequent instances where correction of contractures or impairment of function can be accomplished only by surgical means.

It should be our aim to consider surgical treatment as only an important and sometimes necessary adjunct to a broad therapeutic regimen. While this is the ideal conception in the treatment of the patient with spastic paralysis, it is not always possible. Unfortunately, it is the exception rather than the rule that skilled mental and physical training is available. To be efficient this requires individual instruction over a prolonged period of time on the part of trained personnel. The majority of the patients included in this report have not had available facilities for prolonged pre-operative and postoperative treatment. Hence any improvement resulting after operation must be ascribed to the operation and not to other accessory treatments. An attempt was made to have postoperative training available in all cases of the upper extremity, but in only a few instances was this possible. A reasonable degree of intelligence was considered desirable, but not essential, before operation was performed upon the lower extremity. On the other hand, the use of the upper extremity is intricate and requires at least a fair degree of intelligence to overcome handicaps through postoperative instruction, muscle education, and co-operation on the part of the patient. Fortunately in this respect contracture at the upper extremity occurs only in cases of hemiplegia which is likely traumatic in origin, and in which low grades of mentality are not common.

In our early experience operation upon the lower extremity was sometimes done before the patient could stand alone, that is, before a definite sense of balance had developed. Occasionally, improvement was rapid and the child was able to walk shortly after operation. Further experience taught us that as a rule it is better to wait until the patient is able to stand alone or walk, or until it is apparent that he could stand or walk provided the contractures were relieved.

In the selection of patients for treatment, training or surgical, the question of the patient's mentality commonly arises. For approximately half a century after Little's publications there were practically no attempts made along the line of muscle training. It was supposed that almost all of these patients were feeble minded, and treatment was either not worth while or would be of no avail because of a lack of co-operation. Numerous surgeons observed an apparent improvement in mentality following relief of spasm and contracture, particularly during muscle training. This led many to believe that the mentality in these children is not so low as was formerly assumed, and that a good mind may be masked behind the distortions of the facial muscles, the grimaces of athetosis, or the spasms and deformities of the extremities. It is now known that there is frequently a lack of correlation between motor handicaps and the mental condition. Some patients with a marked degree of speech impairment or loss of muscle control reveal a high degree of intelligence, while others with practically no motor impairment are idiots. The difficulties involved in the interpretation of mental tests and measurements have been studied by Doll (4) in connection with his research at Vineland. At Spalding School in Chicago one-third of a group of 150 children, classed as spastics, were said to have been mentally normal. Doll (3) said, "It is thus evident that the mental condition of birth injured children must be evaluated with more caution, since motor handicap is not to be relied on as an index of the mental condition. Yet to most observers the physical difficulties which these cases present are so

extreme that one is likely to underestimate the child's capacity."

At the close of the first decade of the present century surgical treatment in spastic paralysis had been confined chiefly to stretching of muscles, tenotomies, and tenectomies. Surgeons agreed fairly well upon the usefulness of these methods. There was no agreement, however, on the value of tendon transplantation, and favorable results were attributed to a far greater degree to the removal of the deforming force rather than to the extending action of the flexor muscle. Early work directing the attack upon the central nervous system was in progress. Indeed, we may note the trend of treatment from multiple tenotomies during the first decade to posterior nerve root and motor nerve resection during the second decade, and then through ramisection during the third decade.

Attempts at nerve anastomosis, one peripheral nerve with another, were made by Spiller whose results at first seemed very promising. Steindler showed that while direct neurotization of paralyzed muscle was possible, muscle already supplied by healthy nerve does not take on an additional nerve supply. The clinical application of this is the impossibility of taking some of the nerve supply of the flexors and adding it to that of the extensors.

The suggestion of resection of posterior nerve roots to deal with spasticity and athetosis came from Spiller in 1905, but credit is usually awarded to Foerster who in 1908 and 1909 presented an exhaustive treatise on the theoretical and practical aspects of radicotomy. The Foerster operation was received with great enthusiasm, but has fallen into disfavor chiefly because of the high mortality, the difficult technique, and the inability to localize the effect of root resection to particular groups of muscles.

In 1908, Nutt proposed intraperineural neurotomy with division of the peripheral nerve and immediate suture. Allison and Schwab, impressed with the lack of permanent results following tenotomy, advocated alcohol injection of nerves leading to selected muscle groups. Stoffel proposed selective nerve resection for the purpose of diminishing motor nerve impulses permanently. This method rapidly received recognition and was popularized in this country by Gill.

Sympathetic ramisection, first proposed by Royle and Hunter in 1924 and followed by several subsequent reports, received world wide interest. It is now the opinion of most contributors to the subject that the clinical employment of ramisection in spastic paralysis has failed to give amelioration of symptoms which the first cases seemed to promise.

This brief review is interesting, for of the various methods of surgical treatment which have stood the test of time there remain only motor nerve resection (Stoffel) and the usual orthopedic principles of tenotomy, tendon transplantation, and arthrodesis. The operations forming the basis of this report are tenotomy or tendon lengthening, motor nerve resection, arthrodesis, tendon transplantation, or a combination of these methods adapted to the individual case. End-results will be classified according to the type of operation and the location.

The interpretation of results of treatment is difficult. While results cannot be obtained comparable with the almost complete restoration of function possible in other deformities, a sufficient degree of improvement can be obtained to encourage continuation of efforts to lessen disability as much as possible. From a previously hopeless situation the parents of these children are appreciative of any gain in function. The relief of an unsightly and disabling contracture and physical and moral encouragement unquestionably stimulate the intelligent patient to a better social adjustment. On the other hand our effort is a failure when the correction of deformity does not result in the improvement in function of the part.

MOTOR NERVE RESECTION

Internal popliteal nerve. In several cases a previous lengthening of the tendo achillis had resulted in a recurrence of the deformity. Final decision to lengthen the tendo achillis in addition to motor nerve resection was reserved until the patient was completely relaxed under anesthesia. If, during that time, the foot could not be dorsiflexed to a right angle it was assumed that a structural shortening of the muscle existed, and a plastic lengthening of the tendon was done. In all cases a plaster cast was applied immediately after operation, with care to hold the foot corrected only slightly beyond a right angle. This is most important in order to prevent a subsequent calcaneous deformity.

Results of internal popliteal nerve resection in cases of hemiplegia have been excellent in each of the 43 cases. There has been no calcaneous and no recurrence. Some of the patients now have a slight equinus which is not progressing. This is attributed to conservatism of nerve resection, and particularly to conservatism in fixation of the foot in dorsiflexion only slightly beyond a right angle. In none of these cases, however, was this slight equinus objectionable.

The next group of cases consisted of 20 operations upon 10 patients with a bilateral equinus deformity with no particular spasm of the hamstrings or adductor muscles. This group also gave excellent results. There is no calcaneus in any, but in one case there was a recurrence of equinus deformity. In this particular patient lengthening of the tendo achillis was done in addition to the Stoffel technique. I do not believe that the failure was due to the choice of method but rather to error in judgment in not excising enough nerve.

A third group of cases consisted of 44 operations upon 22 paraplegic patients who also had severe contractures of the hip adductors, and in some contracture of the hamstrings as well. The results in this group of cases showed a recurrence of equinus in 2 cases and a calcaneovalgus deformity in 2 cases. While the results were good, they were not as uniformly satisfactory as in the less severe types. Even though contractures are relieved it does not follow that a good result will be obtained. Three patients, while relieved of the contractures for which they were operated upon, are unable to walk. Mentality is low and there appears to be a complete absence of a sense of balance. Here again, I do not blame the method of the operation itself but attribute failure to poor judgment in the selection of cases for operation.

Obturator nerve. Operative treatment directed toward a relief of spastic adduction contracture was not found necessary in any case of hemiplegia. All operations were done in cases of paraplegia. Fifty-four resections of the obturator nerve were done upon 27 patients. Deformity of the feet, which was usually present, was treated by resection of the internal popliteal nerve or by a stabilizing operation. The results of resection of the obturator nerve have been most satisfactory. A sufficient degree of relaxation of the adductor muscles to correct interference at the knees was obtained in all cases. But here again, as in the last group of cases studied, relief from the adductor spasm does not necessarily indicate a good functional result; for without a sufficient degree of a sense of balance and co-ordination the patient may still be unable to walk. Three patients were not appreciably improved. Therefore, in order to make the operation worth while, cases must be selected with care. Resection of the obturator nerve will relieve spastic adduction provided there is not a severe structural shortening of the muscles as determined by marked limitation to abduction while the patient is relaxed under anesthesia. When this is present, adductor tenotomy is also done. There have been no instances of overcorrection of the deformity or a complete paralysis of the adductor group. Immediately after the completion of this operation a double spica cast is applied holding the legs abducted to a moderate degree. The cast is removed at the end of 4 weeks when walking is encouraged.

Sciatic and external popliteal nerves. Only 4 operations were done on the sciatic nerve with failure to relieve flexion contracture of the knee in both cases of paraplegia. This operation was therefore discontinued, and other methods were used to overcome flexion deformity at the knee. Transplantation of the hamstring tendons and Chandler's transplantation of the patellar tendon downward have given much more satisfactory results, particularly the latter which will be discussed under tendon transplantation.

There were 2 operations performed upon the external popliteal nerve to relieve spasm of the peroneal muscles in conjunction with a triple arthrodesis of the tarsal joints. There was no recurrence of the deformity in either case, but in later cases it was thought to be more rational to transplant the peroneal muscles to the inner border of the foot in conjunction with the triple arthrodesis. This not only removes a deforming force but possibly assists actively in maintaining correction.

Median nerve. The indications for which the Stoffel operation was proposed on the median nerve are spastic contracture of the fingers and thumb, and a spastic contracture of the forearm in pronation. Accordingly with this object in mind 18 operations were performed upon 18 patients with hemiplegia. The technique as described by Stoffel and Gill was used. In some cases a preliminary splint to hold the forearm in supination and the wrist and fingers in extension was applied. Immediately after the operation a plaster cast was applied with the forearm supinated and the fingers and wrist fully extended. The cast was worn, as a rule, about 4 weeks. After the removal of the cast exercises and muscle training were applied for a variable period of time depending on the co-operation of the patient and physical facilities. There were no cases in which tenotomy or lengthening of the flexor tendons of the wrist or digits was done in addition to the nerve resection. In 3 cases a tenotomy of the pronator radii teres was done in addition to division of its nerve supply. The indication for tenotomy was inability to supinate the forearm completely while the patient was under anesthesia. In 8 cases the bundle leading

Fig. 1.

Fig. 1. Recurrence of equinus deformity after 2 operations to lengthen the tendo achillis. There has been no recurrence following a third operation when this was combined with resection of the nerve supply to the gastrocnemius.

Fig. 2.

Fig. 2. Illustration shows result following bilateral nerve resection at the obturators and internal popliteals.

Fig. 3.

Fig. 3. Stoffel's operation of median nerve in spastic hemiplegia. The bundle to the pronator radii teres, flexor carpi radialis, and palmaris longus, was resected together with the bundle to the flexor sublimis digitorum muscle.

to the pronator radii teres, the flexor carpi radialis, and the palmaris longus muscles were resected together with the nerve supply to the flexor sublimis digitorum. This was for relief of pronation contracture of the forearm and flexion contracture of the fingers. In 10 cases the operation was directed toward relief of pronation contracture alone as there was no particular contracture of the fingers present.

The end-results were excellent for the relief of pronation contracture of the forearm. In all cases there has been practically a complete loss of resistance to passive supination, and in most of them there is good active power in supination. I continue to believe, therefore, that this aspect of the Stoffel operation to the median nerve has a distinct value. The results are permanent, and this operation is better than tenotomy alone or transplantation of the insertion of the pronator radii teres according to the method of Tubby. The results of the latter operation will be discussed later.

The results for improvement in function of the fingers, however, are disappointing. Three of the 8 cases are complete failures, 2 have only a fair result, and 3 have good results. A good result means that the patient has good active power in flexion of the fingers with little difficulty in extending them so as to be able to open the hand sufficiently to grasp. The tight flexor spasm of the fingers was relieved in all cases, but in spite of splinting and exercise 5 patients of the 8 could not extend the fingers at will. In these no particular improvement in function resulted. In 2 patients there remains severe palmar flexion of the thumb which is held curled up in the palm.

Failures are indicated by a marked weakness of the extensors of the fingers, or an inability to contract these muscles at will. The fine synergic control of the muscles of the hand cannot be restored simply by weakening the flexor groups. In 4 cases an ulnar deviation of the hand at the wrist occurred resulting likely from the paralysis of the flexor carpi radialis.

The end-results, therefore, of the Stoffel operation on the median nerve are as a whole unsatisfactory. Pronation contracture of the forearm can be relieved, but, as a rule, there will be but little improvement in the use of the fingers. One can not ignore, however, the 3 good results. This means that good results may be obtained in properly selected cases, but the difficulty arises in the selection of them. I would limit the Stoffel operation as applied to the fingers to those cases in which a distinct improvement in the use of the hand is made by preliminary splinting of the wrist and fingers in the cock-up position. If this improvement fails to be maintained and deformity recurs after the splint has been discontinued, an operation to lessen the pull of the flexors may be of benefit. One must have assurance, in other words, that the patient has at least some voluntary power in extension of the fingers while the wrist is in a position of extension.

One may briefly summarize the results of 187 Stoffel operations on 103 patients by saying that motor nerve resection is of great value in the lower extremity, but of limited value in the upper extremity. The operation prevents recurrence of deformity which has been corrected by tenotomy, and in some cases corrects deformity caused by muscle spasm. It is directed toward the relief of spasticity of definite local groups of muscles, and is not indicated in any generalized diffuse spasm of an entire extremity.

TENDON TRANSPLANTATION AND ARTHRODESIS.

Transplantation of the pronator radii teres (Tubby). This operation was done upon 4 patients for the relief of pronation contracture of the forearm. The broad insertion of the pronator radii teres was exposed and entirely severed. The tendon was passed between the radius and ulna and secured by means of silk sutures passed through a drill hole well around the posterior lateral aspect of the radius. The results were all failures. There was not only a failure to gain voluntary supination, but there remained the same resistance to passive supination. All these operations were done before the Stoffel operation was tried, and the results present a marked contrast to the good results obtained by resection of the nerve supply to the pronator radii teres muscle as discussed in the first section of this paper.

Tendon transplantation at the wrist and fingers. Since results obtained by the Stoffel operation on the median nerve were generally unsatisfactory because of inability to extend the fingers and wrist, an attempt was made to combine the good features of the Stoffel as regards the relief of pronation contracture with tendon transplantation of the wrist flexors into the extensor tendons of the thumb and fingers. Of course the usual Stoffel method, which resects the nerve bundle leading to the flexor carpi radialis as well as to the pronator radii teres, had to be modified if we wished to transplant the former. At one operation the median nerve was exposed and with great care the bundle leading only to the pronator radii teres muscle was resected, leaving the nerve supply to the flexor carpi radialis intact. This was done with the assistance of direct electrical stimulation to the nerve. A plaster cast was then applied holding the forearm in supination. Later, when examination proved that the flexors of the wrist were functioning, a second operation was done, namely, transplantation of the flexor carpi radialis around the radius and attaching it to the extensor tendons of the thumb and index finger, and transplantation of the flexor carpi ulnaris around the ulna and attaching it to the extensor tendons of the middle, ring, and little fingers. It was hoped that the pull of these tendons on the extensors of the fingers would enable the patient to hold the wrist in extension as well as to enable him to open the fingers to a degree sufficient to grasp. Of course, good voluntary power of flexion of the fingers with no real spastic shortening was considered essential before operation. These operations were done, at first, with an enthusiasm which gradually waned as time passed to determine the results. While flexion deformity of the wrist was corrected there followed an ulnar deviation at the wrist which sometimes resulted in a hand which looked worse than before operation. Function of the fingers was also not particularly improved. The proximal phalanges were held extended at the metacarpophalangeal joints, but there was no improvement in the flexion deformity of the interphalangeal joints. The function of the fingers was therefore only slightly improved. Upon second thought this is what one would expect. A pull on the extensor tendons does not extend the interphalangeal joints, but only the metacarpophalangeal joints. In paralysis of the musculospiral nerve a similar tendon transplantation is satisfactory because the patient has not

lost the ability to extend the distal 2 phalanges.

Before realizing this an attempt was made to prevent ulnar deviation at the wrist, caused by the spastic flexor carpi ulnaris passed around the ulna, by performing an arthrodesis of the wrist. It was supposed that a bony ankylosis would prevent ulnar deformity at the wrist. Accordingly arthrodesis of the wrist was done on 10 patients. In 5 of these the arthrodesis was combined with transplantation of the wrist flexors as described above. Again ulnar deviation occurred in some cases in spite of arthrodesis. The deforming force of the flexor carpi ulnaris, which appears to be much stronger than that of the radialis, pulled the wrist ulnarwards in spite of arthrodesis.

Arthrodesis of the wrist either alone or combined with tendon transplantation gave better results than tendon transplantation alone. However, 5 failures to prevent severe adduction deformity out of 11 cases indicated that this method of treatment was not satisfactory in a high percentage of cases.

Crossed tendon transplantation. Since it was believed that adduction deformity at the wrist was caused by the excessive spastic pull of the flexor carpi ulnaris, a method of transplantation was next devised crossing the tendons of the flexor carpi radialis and ulnaris attaching the ulnaris tendon to the radial side of the hand and the radialis tendon to the ulnar side. Instead of the usual technique of passing these tendons around the lateral aspects of the ulna and radius, they were passed between these bones just above the wrist. This technique was followed in 16 cases. In 4 of these the flexor carpi ulnaris was sutured to the extensor tendons of the thumb and index finger, and the flexor carpi radialis to the extensor tendons of the middle, ring, and little fingers. In 4 cases the same method of tendon transplantation was done combined with arthrodesis of the wrist. In still another group of 8 cases arthrodesis of the wrist was done combined with crossed tendon transplantation to the bones on the dorsal aspect of the wrist, the flexor carpi ulnaris to the radial border and the flexor carpi radialis to the ulnar border. In none of these 16 cases did adduction deformity at the wrist occur. Therefore, the object of this method of crossed tendon transplantation was realized. Inability to extend the fingers accounts for failure to improve the function of the hand in 4 cases. Crossed tendon transplantation then, is regarded as important in preventing adduction deformity at the wrist in spastic paralysis, for in my experience the usual tendon transplantation of the flexor carpi radialis to the extensor tendons on the radial side of the hand and of the flexor carpi ulnaris to the extensor tendons on the ulnar side of the hand is followed in many cases by a more or less severe adduction deformity. It is not expected that tendon transplantation of a spastic muscle will activate antagonistic action. It is helpful chiefly in removing a deforming force and acting as a passive support.

SUMMARY OF RESULTS OF TENDON TRANSPLANTATION AND ARTHRODESIS OF WRIST, SEPARATELY OR COMBINED

Conclusions as to the value of tendon transplantation and arthrodesis, separately or combined, are based on the results of 34 operations. Seven were cases of uncrossed tendon transplantation of the wrist flexors to the finger extensors; 6 were cases of arthrodesis of the wrist alone, and in another 5 arthrodesis was combined with uncrossed tendon transplantation to the bones of the wrist; 4 were cases of crossed tendon transplantation to the extensors of the fingers; 4 were cases of crossed tendon transplantation to the extensors of the fingers together with arthrodesis of the wrist; and finally 8 were cases of crossed tendon transplantation to the bones of the wrist combined with arthrodesis. It is evident from these confusing figures that attempts at several combinations of tendon transplantation and arthrodesis of the wrist have not resulted in a single satisfactory method of improving the function of the spastic hand. The most satisfactory results, however, have followed arthrodesis of the wrist combined with crossed tendon transplantation to the wrist or extensor tendons of the fingers. A decision is not easily arrived at as to whether one should transplant the wrist flexors to the bones of the wrist or to the extensors of the fingers.

Objection may be raised as to the efficacy of transplantation of a spastic muscle, particularly to a contrary position. In practice these objections are partially confirmed. However, in a goodly proportion of cases improvement in power of extension of the fingers can be obtained by this means not possible by any other method.

Selection of cases for operation is not easy. If, when the flexed wrist is held passively in extension and the patient is still able to open the fingers sufficiently to grasp, assuming, of course, that there is good voluntary flexion of the fingers, crossed tendon transplantation will likely hold the wrist in extension without adduction deformity. If there is difficulty in extension of the fingers while the wrist is held passively extended, tendons are transplanted to the extensors of the thumb

Fig. 4.

Fig. 4. Arthrodesis of the wrist together with uncrossed tendon transplantation. Note the severe adduction deformity. The tendons of the flexor carpi radialis and the flexor carpi ulnaris were passed around the radius and ulna respectively and attached to the carpus. This deformity is common with this method of transplantation.

Fig. 5.

Fig. 5. Nerve resection to the pronator radii teres muscle only. At a second operation the flexor carpi radialis and flexor carpi ulnaris were transplanted to the dorsum of the wrist according to the crossed technique.

and fingers, otherwise the patient would be unable to open the fingers sufficiently to grasp. With arthrodesis of the wrist it is advisable to transplant the wrist flexors. These muscles would have no function anyway after arthrodesis; and when transplanted, according to the crossed technique, they will prevent adduction deformity. A large number of patients, however, have fair function in spite of a flexed position of the wrist, for by flexing the wrist they are able to extend the fingers. It is best not to interfere with this type of hand. Possibly transference of the origin of the extensors further upward on the humerus would improve the ability to hold the wrist and fingers extended.

On the whole the results of tendon transplantation and arthrodesis in the upper extremity are discouraging. In a selected group of cases, however, a great improvement in function of the hand can be obtained by these measures. Spastic flexion of the thumb across the palm seriously interferes with the ability to grasp. Arthrodesis of the carpometacarpal joint together with tenodesis of the abductor pollius longus to the lower end of the radius has been partially successful in holding the thumb out of the palm.

Transplantation of the biceps femoris. This operation was done to prevent sagging of the knees in flexion. This was always bilateral and has not been observed in any case of hemiplegia. Eighteen operations were done on 9 patients. The usual technique was employed, namely, a small piece of the bony attachment at the head of the fibula was removed together with the biceps tendon, and this was secured into a groove in the patella. Complete passive extension of the knee was a prerequisite before operation. One can not expect a transplanted tendon to overcome contracture. In 2 cases flexion contracture was severe, and required posterior capsuloplasty according to the method of Philip Wilson in order to obtain complete passive extension before tendon transplantation. In 5 cases the result was satisfactory. These patients are able to walk with the knees almost completely extended. In 2 the result was considered only as fair; in the remaining 2 cases no benefit whatever was derived. Possibly a higher percentage of good results may have been obtained by transplanting both the external and internal hamstrings. The same objections hold true here as with transplantation of spastic muscle at the wrist. Possibly the same percentage of good results could have been obtained by tenotomy or tenectomy of the hamstrings. Tendon transplantation was done in order to utilize this force, if possible, by

Fig. 6.

Fig. 6. Crossed tendon transplantation to the wrist together with arthrodesis. There is no adduction deformity. The tendon of the flexor carpi ulnaris was passed between the radius and ulna and attached to the radial border of the wrist. There has been a moderate improvement in the function of the hand.

Fig. 7.

Fig. 7. Arthrodesis of the wrist has resulted in inability to extend the fingers. The patient was formerly able to extend the fingers by flexing the wrist. One must be cautious when advising arthrodesis of the wrist without tendon transplantation to the extensor tendons of the thumb and fingers.

transferring the action toward the extension of the knee.

Transplantation of the patellar tendon (Chandler's operation). In 1933 Chandler, at a meeting of the Clinical Orthopedic Society in Chicago, demonstrated patients upon whom he had transplanted the patellar tendon downward at the knee (2). Since that time the writer has done 10 of these operations on 6 patients, all with spastic paraplegia. Results have been very satisfactory, and each patient now has active power in completely extending the knees when sitting and walking. This operation was proven to be so satisfactory that, in my hands, it has completely displaced transplantation of the hamstrings. Of course, as in transplantation of tendons elsewhere, complete passive extension of the knee must be possible beforehand, obtained either by stretching, tenotomies, or capsuloplasty, for tendon transplantation alone will not overcome contracture.

Arthrodesis and tendon transplantation at the foot. Deformity of the foot other than a pure equinus has been observed with relative infrequency. This accounts for the few operations to correct a lateral deformity of the foot in spastic paralysis. Twenty operations were done on 12 patients for varus or valgus deformity. Subastragalar arthrodesis together with transplantation of the peroneus longus or tibialis anticus was done upon 14 patients, and in one case arthrodesis alone was done. Tendon transplantation in conjunction with arthrodesis removes the constant deforming force of a spastic muscle and lessens the likelihood of recurrence of deformity. The results of all these operations were satisfactory. It is believed necessary to dress these feet in a little more overcorrection than is done following arthrodesis of the foot to correct a paralytic deformity, as there seems to be a greater tendency toward recurrence. Subastragalar arthrodesis together with tendon transplantation solves the problem to correct valgus or varus deformity of the foot in spastic paralysis. Arthrodesis alone is apt to result in a recurrence of the deformity.

Posterior nerve root resection (Foerster) and sympathetic ramisection. While it is not intended in this report to discuss the merits of nerve root resection and sympathectomy, brief comments will be made to record unfavorable impressions following my observation of patients operated upon by others. Two patients were under observation several years after posterior nerve root resection. Both had large trophic ulcers and a flaccid paralysis of the lower extremities with calcaneovalgus deformity and flexion contractures at the knees. One patient was incontinent and

died 10 years after operation because of sepsis. Ten patients were studied following sympathetic ramisection, and I have not been impressed with any improvement over their previous condition. In 2 cases of paraplegia, where the operation was done on only one side, there was no appreciable difference between the operated and the unoperated sides. These observations in general agree with other reports. One can not ignore, however, the careful studies of Steele Stewart who has had great experience with sympathectomy.

CONCLUSIONS

In this study of end-results of the surgical treatment of spastic paralysis the striking contrast of poor results attending operation at the upper extremity as compared to good results at the lower extremity is apparent. Motor nerve resection combined with tenotomy when necessary, has proved to be satisfactory in correcting equinus deformity and adduction contracture at the hips which are the deformities most commonly encountered. The likelihood of overcorrection of the deformity is more theoretical than real, for with care in judgment in the execution of nerve resection this should not occur. Valgus or varus instability or deformity at the foot may be corrected by subastragalar arthrodesis combined with tendon transplantation. Motor nerve resection of the sciatic nerve to control flexion deformity at the knee has been discarded as being of little value, and transplantation of the biceps femoris has been attendant with only indifferent success. Transplantation of the patellar tendon downward—advancement of its insertion—has shown such superiority over other methods to correct flexion deformity at the knee as to displace them entirely. I have had no experience with Durham's procedure of dividing the insertion of the internal rotator muscles at the hips to correct internal rotation contractures. His results are convincing and his method will be used when the opportunity arises.

To improve the function of the upper extremity is a much more difficult problem and is still not possible in many cases. It is best not to interfere with many of these for an injudicious operation may result in an impairment of what little function exists. Motor nerve resection at the upper extremity has a narrow field of adaptability except for relieving pronation contracture of the forearm. Arthrodesis and crossed tendon transplantation offer better chances of success in carefully selected cases resulting occasionally in striking improvement. However, even with various combinations and methods the results of tendon transplantation and arthrodesis have been, as a whole, disappointing. While the nature of the lesion precludes curative treatment, the application of surgical methods, unsatisfactory as they are, is often an indispensable aid in further educational treatment.

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A TECHNIQUE OF THYROIDECTOMY PERMITTING THE USE OF SILK

DONALD GUTHRIE, M.D., F.A.C.S., Sayre, Pennsylvania,
MERLE J. BROWN, M.D., Davenport, Iowa

THE general principles of thyroidectomy have become standardized but important variations and refinements of technique have been described in recent years which have improved results and decreased operative complications. The technique developed in this clinic has increased rapidity of recovery, decreased hospital morbidity, eliminated drainage, decreased incidence of infected wounds, and diminished incidence of postoperative complications.

In 1920, Pemberton suggested the primary superior polar attack for substernal thyroids and from the principles outlined our present method has been evolved. This method of attack is now applied to all types of goiters with equal effectiveness. Guthrie (1936) stated that the advantages of the method are obvious when the primary superior polar method used in substernal goiter is compared with the technique of rapid elevation, which is attended so often by an increase in respiratory difficulties instead of in their improvement, which may necessitate the rapid and vain search for a hidden and deformed trachea in a neck already filled with thyroid before elevation of more thyroid, which carries with it the danger of further stretching an already overstretched recurrent laryngeal nerve, and which may be associated with deep alarming hemorrhage due to the pulling off of the inferior thyroid artery and vein, or both, and thus cause injury to the recurrent laryngeal nerve, the internal jugular vein, or the parathyroids, as a result of hectic efforts to control the severe and alarming hemorrhage.

Since the employment of this operative method, there has been a marked reduction in the postoperative respiratory and voice complications and there has been no need for tracheotomy for the relief of such complications. Lahey has recently advised that the recurrent laryngeal nerve be visualized and dissected out in order to prevent its injury and subsequent voice changes. Guthrie, however, believes that severing the inferior

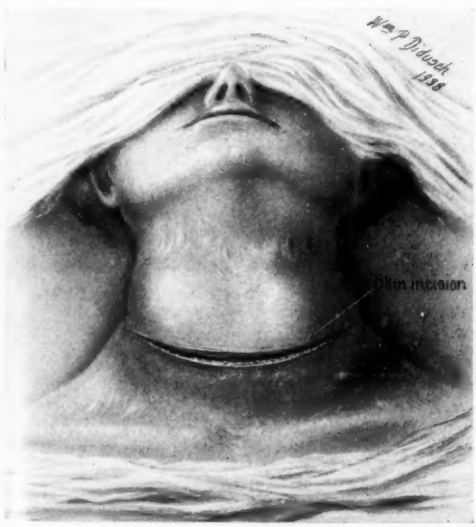

Fig. 1. In those patients with large thyroids the incision is placed high to prevent its prolapse upon the chest wall.

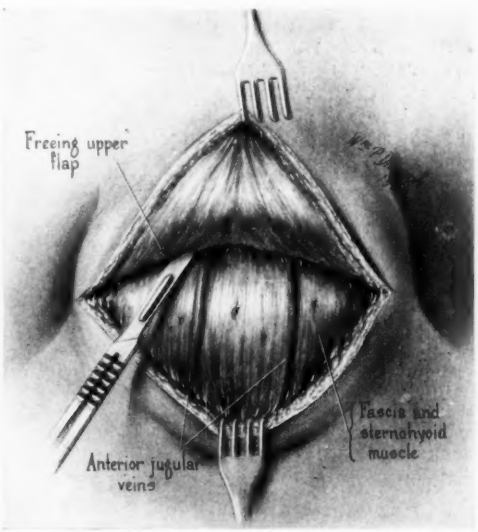

Fig. 2. Sharp dissection of the upper flap of the incision is carried out.

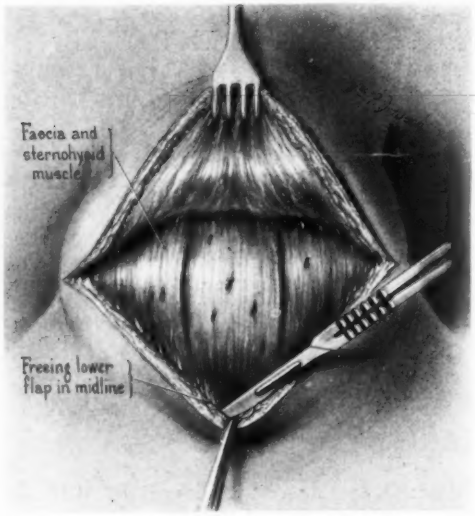

Fig. 3. Freeing the lower flap in the midline only over the suprasternal notch.

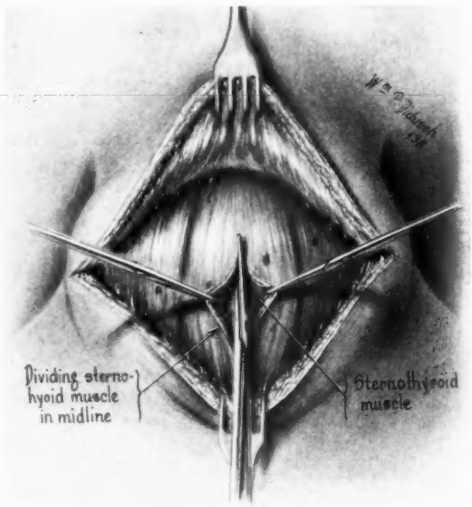

Fig. 4. Division of the fascia and the muscles in the midline.

thyroid vessels high up on the gland and then ligating the vessels in the long axis of the neck safeguards the recurrent laryngeal nerve against injury at this point.

The technique which we now employ permits the safe use of silk. Halsted was the first surgeon in this country to use silk in wound repair, and the principles he proposed have not been improved upon. He believed that, even in the presence of slight infections, fine silk sutures would not be extruded. Howes and Harvey have shown that there is much less exudate and cellular response to

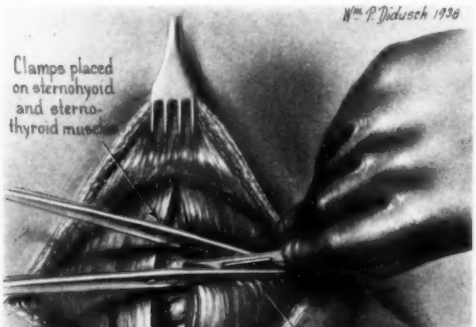
Wm. P. Didusch 1930
Clamps placed on sternohyoid and sternothyroid muscles
Thyroid
Dividing sternohyoid and sternothyroid muscles to provide better exposure when a very large gland is present

Fig. 5. Dividing the sternohyoid muscle to provide an adequate exposure.

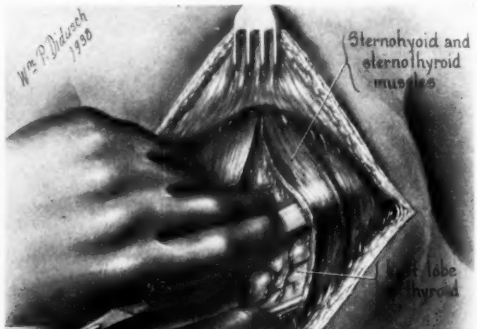

Fig. 6. Freeing the thyrohyoid muscle completely from its attachment to the lobe of the thyroid.

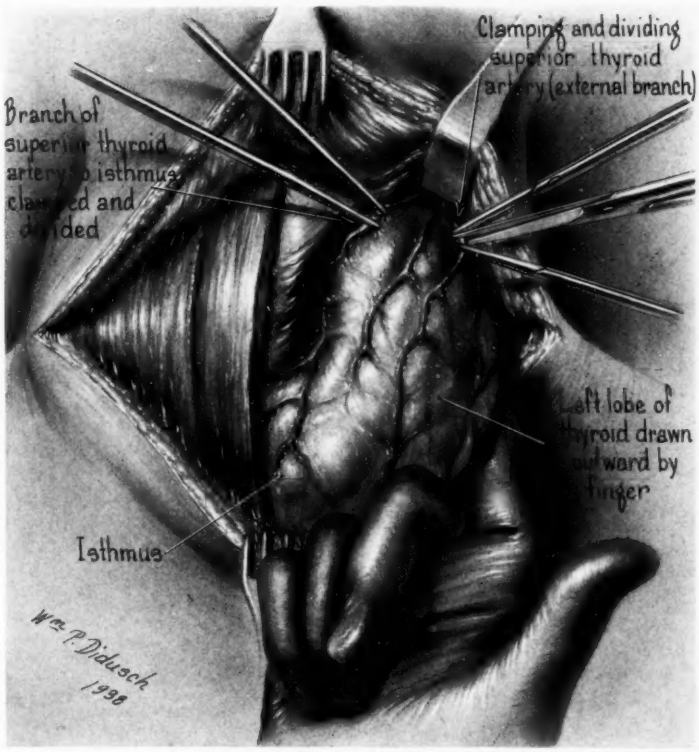

Fig. 7. Method of clamping and dividing the superior thyroid artery with gentle elevation of the gland.

silk in tissue than to catgut. They showed that silk knots and sutures become encapsulated early by a fibroblastic capsule. We have had a chance to verify this fact in secondary lobectomies which are performed 7 to 10 days after the primary operation. We have been amazed to find in this short period of time all silk ligatures encapsulated. Whipple, in 1933, emphasized the principles laid down by Halsted, and the spreading popularity of silk is largely due to his efforts. He emphasized the necessity of sharp dissection, complete hemostasis with fine pointed forceps, avoidance of mass ligatures and undue tension, interrupted sutures, avoiding the combination of silk and catgut in wounds, and the use of only the finest grades of silk in clean wounds. These principles are rigidly observed in our thyroidectomy technique. Guthrie and Sharer (1936) stated that in thyroid surgery the desire to close the wound if possible without drainage necessitated the use of large amounts of catgut for complete hemostasis. The exudative response to this material caused serum collections which often required drainage and thereby invited infections. The swelling and softening of catgut about larger vessels may result in hemorrhage which may be concealed. Silk has been advocated for the solution of these difficulties. Guthrie and Sharer, in 1935, reported its use in ligation of all vessels while the hemostasis of the thyroid remnant was secured by a running lock suture of No. 0 iodized catgut. Before this change of technique, drainage was employed routinely. This method permitted 60 per cent of the wounds to be closed without drainage. The wounds drained were particularly those with large unobliterated cavities. By this method there was a definite reduction in the incidence of wound infections and serum collections. Goiter patients in this clinic have been routinely tested for sensitivity to silk and it has been found that,

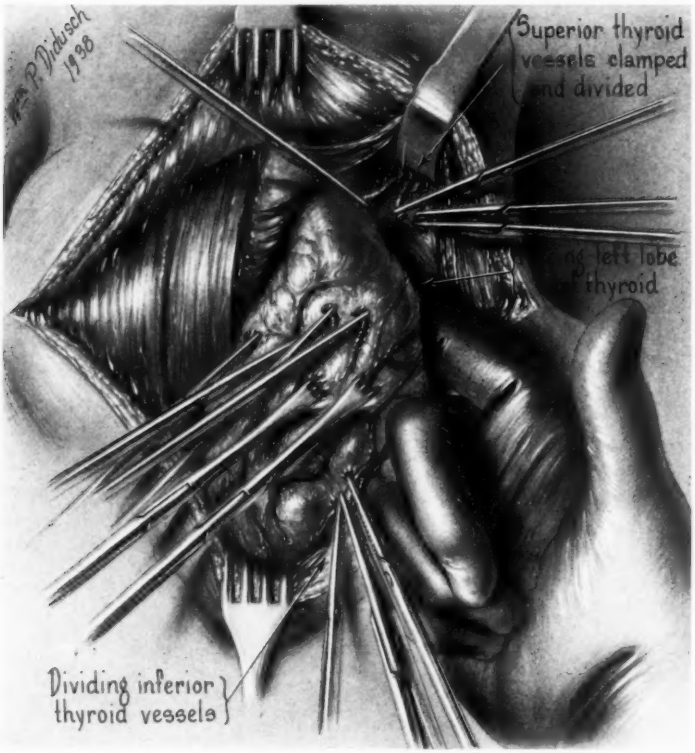

Fig. 8. Upper pole is mobilized by gentle downward traction.

even in those who react strongly positive, the tendency to serum collection is definitely less than for catgut. The silk used in all cases has been fine Deknatel or a fine German made white silk.

In 1935, when silk was used for ligatures and remnants were sutured by a lock stitch of iodized No. 0 catgut, 63 per cent of the wounds were healed at the time of discharge. A summary of the cases up to June 22, 1937, showed that 62 per cent were closed without drainage and 61 per cent of these healed without serum collections while 32 per cent of the drained cases healed *per primam*. A total of 82 per cent of these patients were healed at time of discharge. Before the rubber sponge pressure dressing was routinely used in silk and catgut cases 40 per cent of the wounds were draining after 13 days but, since the adoption of this dressing for all goiter cases, only 17 per cent were draining after 11 days. Further, in cases in which silk and catgut were both used, serum collections were noted in 32 per cent.

In a review of the last 150 cases which have been completely done with silk there has been only one case requiring drainage. The drains were removed in 24 hours, and primary healing resulted. There have been only 5 cases which developed serum collections and these became dry after a single drainage of the serum. Of these 150 cases there has been only one infected wound, which was slight and subsequently healed without extrusion of silk knots.

When these figures are compared to reviews of cases for previous years, there has been a remarkable improvement since the present technique has been used. Another very important point is that substernal goiters which were previously drained routinely are now closed without drainage and without fear of mediastinitis. It was our custom formerly to drain these pockets freely at least 3 or 4 days. At the Mayo Clinic, Zellhoefer, in 1934, found that when local anesthesia was used in 80 per cent of the cases the wounds were

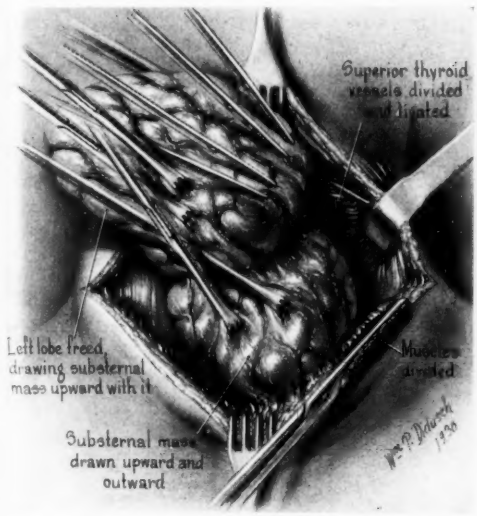
Superior thyroid vessels divided and ligated
Left lobe freed, drawing substernal mass upward with it
Muscles divided
Substernal mass drawn upward and outward

Fig. 9. Illustrating the method of elevating a substernal mass by gentle traction after primary mobilization of the superior pole and severing the lateral veins.

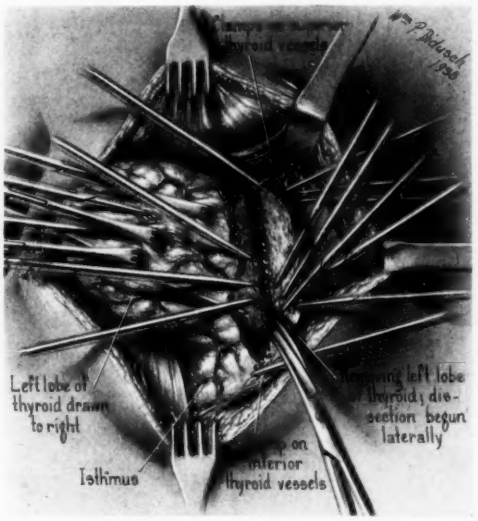

Fig. 10. Dissection of the lobe continued to show what should be the size of the thyroid remnant that is to be left *in situ*.

draining after 2 weeks. By improving the technique of regional anesthesia in 1935 drainage was reduced to 52 per cent. Coller reported, in 1937, that he uses drainage routinely in his cases.

TECHNIQUE OF SUBTOTAL THYROIDECTOMY

It is most important to obtain the best exposure of the thyroid bed at the beginning of the operation. The low collar incision (Fig. 1) extends from the external jugular vein of one side to its fellow of the opposite side, and the skin and platysma of the upper flap are reflected upward to the level of the thyroid cartilage notch (Fig. 2). It has been found best not to dissect the lower skin flap except slightly at the suprasternal notch (Fig. 3), because separation of this flap is not necessary for exposure and its dissection encourages the formation of serum pockets. All vessels are caught by fine pointed Kelly hemostats and ligation is performed with fine silk. In dissecting the flap, care is taken to avoid cutting the anterior jugular veins. If these veins are injured the heart side of this vein is immediately clamped to prevent air embolism, as previously described by the senior author. At the point of injury the vein is completely severed before ligation because it is believed that there is less likelihood of the sutures slipping off as the operation proceeds and retraction is used. At this point all forceps which have been used to secure vessels on the flaps and muscles are removed after ligation of the vessels. The fascia and muscles are

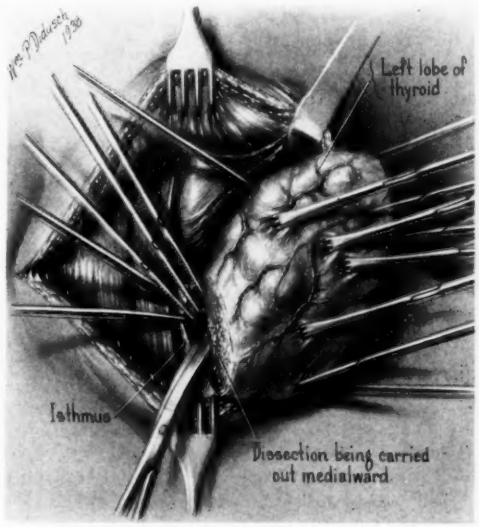

Fig. 11. Dissection of the lobe from the trachea showing remnant of the gland left along the trachea.

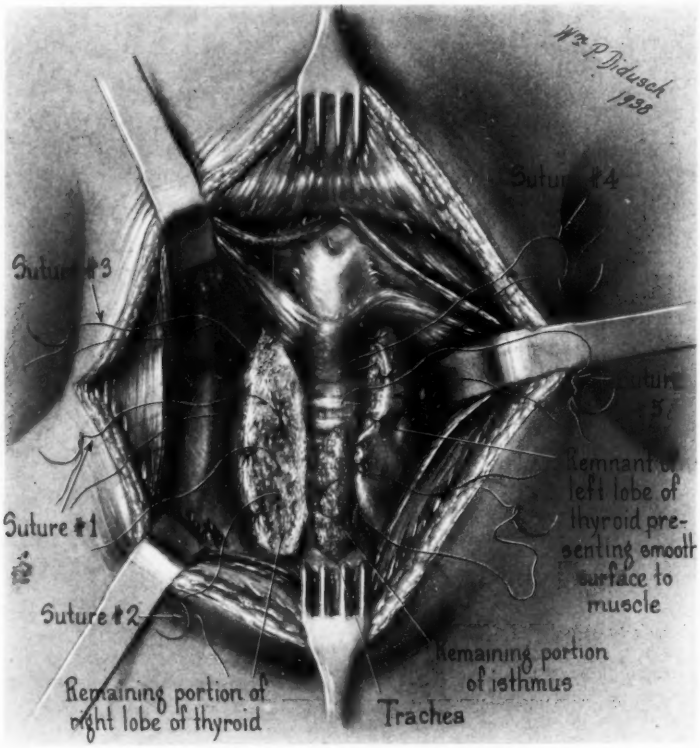

Fig. 12. Method of controlling hemorrhage from the remnant by two rows of interrupted fine silk sutures placed at different levels in the long axis of the neck. Interrupted sutures are placed through the edges of the remnant and the fascia and thyroid tissue of the trachea inverting the outer surface of the remnant to conceal its incised surface.

separated in the midline (Fig. 4) and at the suprasternal notch care is taken to avoid injury to the venous jugular arch. The sternohyoid muscles may be clamped and divided on one or both sides and the sternomastoid may be separated from the sternohyoid muscle and retracted laterally if exposure is inadequate (Fig. 5). Free separation of the thyrohyoid muscle from the gland is important (Fig. 6).

The larger thyroid lobe is attacked first. The lobe is elevated by goiter tenacula and the suspensory fascia is severed. As the upper pole is elevated the branches of the superior thyroid artery are clamped by Kelly hemostats and divided (Fig. 7). There are usually three or five terminal branches. After severing the arterial branches, the superior pole, which tends to be flattened and wedge shaped, rolls outward from its bed with perfect ease (Fig. 8). After the pole is mobilized a small strip of thyroid is left to form the upper part of the remnant in order to protect the recurrent laryngeal nerves which are the most vulnerable in this area of the thyroid field. It is believed that dividing the branches of the superior thyroid artery rather than the main artery or mass ligation of the superior pole has many safeguards. It avoids a mass ligature which often must be placed with poor exposure and under tension, thus lessening the chance of immediate or postoperative hemorrhage from the superior thyroid vessels. We believe this prevents injury to the blood supply of the parathyroids because of the absence of permanent tetany in more than 4,100 of our operative cases. It also safeguards the internal branch of the superior laryngeal nerve which is now known to contain motor fibers to the

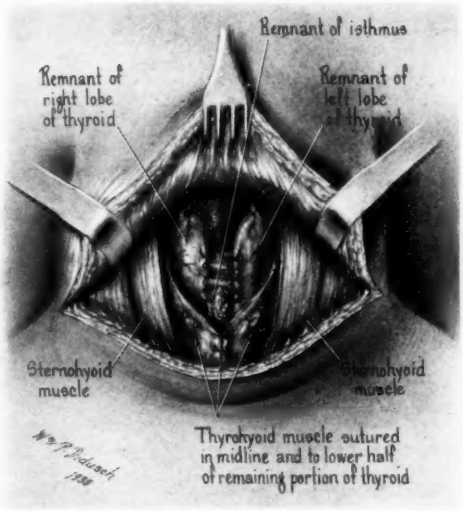
Remnant of isthmus
Remnant of right lobe of thyroid
Remnant of left lobe of thyroid
Sternohyoid muscle
Sternohyoid muscle
Thyrohyoid muscle sutured in midline and to lower half of remaining portion of thyroid

Fig. 13. Thyrohyoid muscles are sutured at the midline and to the lower portion of the remnant.

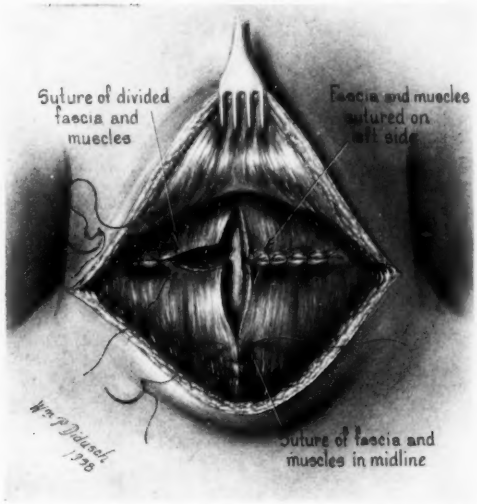

Fig. 14. Method used in the closing of the divided sternohyoid muscles.

interarytenoid muscles. The dissection then extends to the lateral thyroid veins, which are clamped and ligated. With this amount of mobilization the upper pole is elevated and drawn gently downward from without inward or in a reverse manner, the manipulations of the surgeon being guided by the respiration of the patient and the helpful co-operation of an experienced anesthetist.

In the dissection at this stage it is best to leave small amounts of thyroid tissue on the trachea and at the side for protection of the trachea itself and for anchoring the remnant. It was formerly thought that the lower pole was most frequently the site of nerve injury, but it is now well known that injuries take place most frequently in the groove between the esophagus and the trachea or near the upper pole. Lahey believes that many of these nerve injuries come from attempts to control troublesome hemorrhage from a branch of the inferior thyroid artery supplying the remnant left along the side of the trachea, and he advises that the inferior thyroid artery be ligated to control such hemorrhage.

The ascending branches of the inferior thyroid artery are next encountered and after these are severed a wide degree of mobility of the gland is found possible. In fact, very often a large substernal mass may be elevated into the wound by the most gentle traction without inserting the finger into the mediastinum (Fig. 9). This is necessary for ligation of the lower pole and removal of the gland.

The remnant of the lobe is outlined by Kelly hemostats placed along the periphery of the lobe (Fig. 10), as the lobe is divided the blood vessels in the thyroid substance are clamped

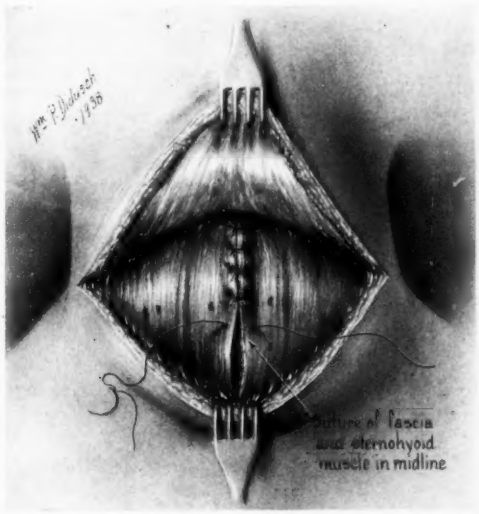

Fig. 15. Closure of muscles and fascia in the midline when the sternohyoid muscles are not divided.

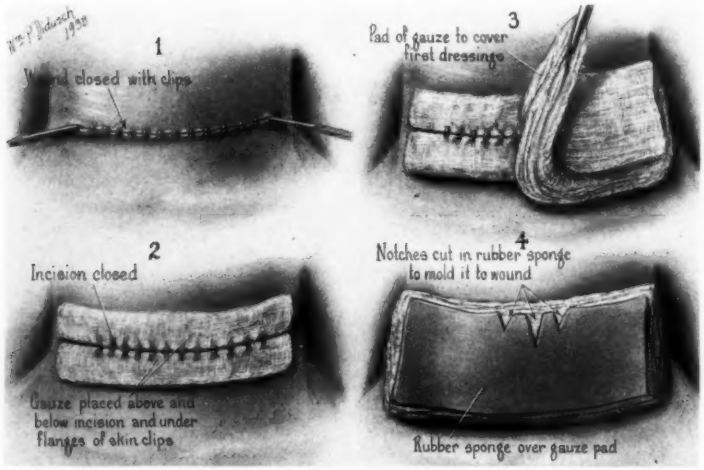
1
Wound closed with clips
2
Incision closed
Gauze placed above and below incision and under flanges of skin clips
3
Pad of gauze to cover first dressings
4
Notches cut in rubber sponge to mold it to wound
Rubber sponge over gauze pad

Fig. 16. Illustrating the method of dressing the wound.

(Fig. 11). All vessels are ligated with fine Deknatel or a German made white silk. The remnant is fairly dry and is dropped into the thyroid bed while the remaining lobe is removed in a similar way. Two rows of interrupted fine silk sutures are placed in the cut surface of the remnant in the long axis of the neck for hemostasis and not too deeply placed to protect the nerves and parathyroids (Fig. 12.) The remnants are then drawn to the midline and sutured by fine silk to the fascia of the trachea and the thyroid tissue is left along the trachea. The thyrohyoid muscles are then brought back to their original location and sutured together and to the lower portion of the remnant. This is an additional aid to complete hemostasis (Fig. 13). Closure is accomplished by using interrupted fine silk sutures (Fig. 15). When the sternohyoid muscles have been divided, the severed ends of the anterior jugular veins are ligated separately by transfixion sutures and then the edges of the muscles are sutured together by interrupted sutures (Fig. 14). The skin edges are brought into exact approximation and Van Wachenfeldt clips are applied (Fig. 16, *1*). Beneath the flanges of the clips on either side a saline soaked gauze is then placed over the closed wound as shown in Figure 16, *2*, and the entire wound is covered by a flat dry gauze dressing (Fig. 16, *3*). An ordinary flat rubber sponge, with notches cut in the upper edge to permit molding to the neck, is placed as in Figure 16, *4*, for distribution of pressure over the entire area of

Fig. 17. Illustration of the condition of the wounds on the fourth postoperative day.

Fig. 18. Showing the condition of the wounds on the seventh postoperative day.

the wound. This dressing is covered by two pieces of sterile cotton and the entire dressing is bound snugly to the neck by means of a gauze bandage.

On the day following operation the dressing is removed and every other skin clip is removed. The pressure dressing is replaced by a flat gauze dressing. After 48 hours the remaining skin clips are removed while after the fourth or fifth postoperative day the dressing may be disposed of entirely.

The patients are discharged in from 8 to 10 days after operation, this period of time being necessary for the symptoms of hyperthyroidism to quiet down. Hospital morbidity is thus from 3 to 7 days less than for previous methods.

SUMMARY

The technique of subtotal thyroidectomy as performed in this clinic, and as shown by the illustrations and the description, has proved satisfactory.

The use of silk in thyroid surgery is entirely justified by the results that have been obtained in wound healing.

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TUBAL RESECTION AS A TREATMENT FOR RECURRENT GONORRHEAL SALPINGITIS

HENRY C. FALK, M.D., F.A.C.S., and GEZA WEITZNER, M.D.,
New York, New York

SALPINGITIS is a well defined clinical entity and constitutes one of the most important chapters in gynecology. The salpingitides are divided on an etiological bases into 3 groups: gonorrheal salpingitis, septic salpingitis, and tuberculous salpingitis. In this discussion the term recurrent salpingitis will be used as a synonym for recurrent gonorrheal salpingitis.

Practically every case of primary gonorrheal infection of the tube can be cured if re-infection can be prevented. A woman who is financially able to take care of herself and who is willing to follow instructions carefully can be promised an almost complete recovery under proper medical treatment. The difficulty in any large city lies in the following facts: first, the patients, not understanding the seriousness of their condition, will not follow the instructions given them; second, if they understand the seriousness of the condition and desire to follow the instructions, they cannot because of their financial condition which requires them to return to work too soon; and lastly, most of these patients have to support themselves, therefore, they cannot interrupt their periods of occupation too frequently or they lose their positions. As a result of these factors a great many patients in our city institutions must be operated upon, not because of the pathology present but to prevent frequent attacks of incapacitating symptomatology.

What operative procedure shall be the one of choice in these cases? Salpingectomy is a relatively safe and useful operation if practised in accordance with the principles laid down by Simpson and Curtis. Yet it has several disadvantages: (1) It has a primary mortality of 1 per cent and a fairly high percentage of postoperative morbidity. (2) The technical difficulties encountered during the operation frequently leads to radical surgery of the ovaries and uterus, producing a surgical menopause, which is contrary to all principles of conservative gynecology. (3) Postoperative exudates or indurations may require prolonged treatment or even a secondary operation (Norris 5.8 per cent). Postoperative cyst formation in the ovaries due to impaired circulation and postoperative adhesions producing symptoms do occur. (4) The loss of the fallopian tubes occasionally has a bad psychological effect on some patients.

The operation to be described is presented as a conservative procedure to prevent the above described sequelæ. It retains the tubes and prevents their re-infection. The observations (2) which furthered the belief that this procedure would and could prevent re-infection of chronically infected tubes were that:

1. In spite of the known fact that a gonorrheal infection of the tubes is always bilateral, patients were seen frequently who had a pus tube on one side and a fairly normal tube on the other. As a result of this observation several of these apparently normal tubes were removed and examined. It was found that in the apparently normal tube there always was an obstruction at the uterine cornu, whereas in the pus tube on the other side, the connection with the uterine cavity seemed to be maintained.

2. When a hysterectomy was performed on a patient with chronic bilateral tubal infection, the inflammation disappeared and re-infections did not occur. In looking over the literature, hysterectomy is found to be described as a treatment for pus tubes (4).

3. When a patient with quiescent pus tubes was adequately treated so as to remove all gonorrheal infection from the lower genitalia (cervix, urethra, etc.) and she was separated from her consort to prevent re-infection, the tubal infection as a rule cleared up and did not recur.

4. Simpson and Curtis have shown that gonorrheal salpingitis is a self-limited disease and the organisms die in the tube 2 weeks after the temperature is normal. As a result the tube cannot re-infect itself; the infection must come from without the tube.

5. Those patients, whose tubes had been resected close to the uterus for sterilization purposes, never developed salpingitis in spite of a gonorrheal infection of the lower genital tract (cervix, urethra, etc.), thus showing that gonorrheal

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infection does not go by way of the blood stream or lymphatics but travels along the cavity of the uterus to the tubes.

As a result of this study, 5 conclusions were reached: (1) When a patient had a complete occlusion at the uterine end of the tube, tubal infection did not recur and pus tubes did not develop; (2) that the uterus was the necessary avenue through which the infection reached the tubes from the cervix and the external genitalia; (3) that even in the presence of the uterus, a total absence of infection from the internal os downward prevented re-infection; (4) the cured infected tube did not spontaneously re-infect itself; (5) salpingitis did not develop in those patients in whom the connection between the uterine cavity and the tubes had been broken in spite of a gonorrheal infection of the lower genital tract.

It was then argued that if these conclusions were correct, 1 of 4 procedures could be followed in order to prevent re-infection of the tubes: (1) Clear up all foci of infection and not allow sex trauma; (2) do a hysterectomy; (3) remove the infected tubes with or without fundectomy; or (4) resect the tubes at the cornu of the uterus.

Which procedure should be followed? Procedure 1 could be followed if the patients would co-operate, but it is practically impossible to prevent sex trauma. Re-infections have occurred in some cases following sex trauma where one could absolutely exclude re-infection from the consort. As a result of the impossibility of control the first procedure, although it can be carried out, is usually doomed to failure.

Procedure 2, or hysterectomy, is rather radical surgery for infected tubes; patients will not submit to it, the mortality and morbidity is too high, and it breaks every principle of preserving as much of the pelvic organs as possible.

Procedure 3, or the removal of the tube with or without resection of the fundus, is an excellent procedure but still somewhat radical. In removing the tubes with or without a piece of the fundus, the blood supply to the ovaries may be interfered with, and those patients on follow-up frequently present ovarian cysts with associated symptoms.

Procedure 4, or the resection of the tubes, carries with it a minimum of surgery; and if it will clear up the condition and prevent re-infection, it should be the method of choice.

Tubal resection is indicated in those patients who have had repeated attacks of salpingitis covering a period of one year with a relative disability or incapacity for work during this time. They should give a history of sterility during this period and on vaginal examination should show persistent palpable masses.

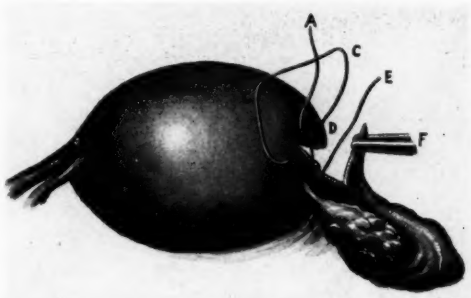

Fig. 1. Figure-of-8 suture *A*, *B*, *C*, *D*, *E*, inserted through the cornu of the uterus, clamp *F* applied to uterine end of tube. V shaped excision of the uterine end of tube. The mesosalpinx is cut close to the tube so as to free slightly the uterine end of the tube.

Surgically the requirements are that the patient be a good surgical risk as far as her other vital organs are concerned. She must have had a normal temperature for at least 14 days with a leucocyte count of less than 10,000 and a sedimentation time longer than 30 minutes for 18 millimeters in the Linzenmeyer tube.

TECHNIQUE OF THE OPERATION

The abdomen is opened by a left paramedian incision from the symphysis to the umbilicus. After insertion of the self-retaining retractor, 3 laparotomy pads are placed so as to pack away the omentum and intestines. The adhesions of the omentum and small intestines to the pelvic organs are severed by blunt or sharp dissection. The fundus of the uterus is identified and the adnexa are inspected. *The condition of the ovaries is the deciding factor for the type of operation to be performed.* If ovarian pathology such as abscess or cyst is found, a salpingo-oophorectomy is performed. If no ovarian pathology is found, a resection of the tube can be carried out.

A figure-of-8 stitch (Fig. 1, *A-B-C-D-E*) is inserted in the uterine horn, proximal to an artery clamp (Fig. 1, *F*) placed on the uterine end of the tube. A V shaped excision of the uterine end of the tube is carefully made so as not to injure the underlying ovarian branch of the uterine artery. The proximal end of the tube is then freed from its mesosalpinx by cutting the mesosalpinx close to the tube for a distance of about 1 centimeter. The figure-of-8 suture, *A* to *E*, in the uterus is tied, left long, and a clamp is applied.

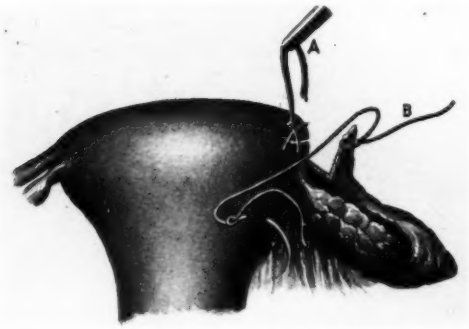

Fig. 2. *A*, Cornual, figure-of-8, suture tied. Ligature placed around uterine end of tube, *B*, and tied. Long end of suture threaded on a needle and passed through posterior wall of the uterus *C*, from medial to lateral, under the round ligament of ovary.

Fig. 3. All sutures tied. Uterine end of tube inverted covering all raw areas.

A ligature is then applied to the cut end of the tube (Fig. 2, *B*) and the clamp is removed. The long end of this suture is threaded on a needle which is passed through the posterior wall of the uterus below the round ligament of the ovary (Fig. 2, *C*) and tied. This automatically causes the cut end of the tube to be inverted under the tube itself (Fig. 3, *B*). The same procedure under the same conditions is carried out on the other side.

RESULTS

In this series, 112 patients have been operated upon; the first operation was performed May 17, 1934; the last included in this series was done on November 28, 1936.

Pre-operative data. The youngest patient was 20 years old, the oldest was 42; 87 patients were in the 20 to 29 year group; 23 in the 30 to 39 year group, and only 2 were 40 years or over. The shortest pre-operative stay in the hospital was 2 days, the longest period 60 days, and the average was 17.3 days. All patients complied with the routine conditions and indications for the operation.

The operations performed were as follows: bilateral resection in 52 patients; left salpingo-oophorectomy, right tubal resection in 32; right salpingo-oophorectomy, left tubal resection in 28; ovarian suspension in 18; uterine suspension in 92; and appendectomy in 79.

The following pathological lesions were seen at operation and allowed to remain in the pelvis: A small mass; the tube measuring up to 2 centimeters was found 51 times; a medium sized mass, pyosalpinx, the tube measuring 3 to 4 centimeters, was seen 35 times; a large mass, the tube measuring more than 4 centimeters in diameter, occurred 26 times.

In 106 patients the operations were performed as the operation of choice; on 6 occasions they were performed as operations of necessity. In these latter cases, the surgeon's intention was to do some other type of procedure but the difficulties encountered made it advisable to shorten the operation. As a result a cornual resection was resorted to instead of the usual salpingectomy or salpingo-oophorectomy. The 106 operations of choice were performed without operative complications and without drainage. The 6 operations of necessity were all drained, 4 abdominally and 2 vaginally.

POSTOPERATIVE COURSE

In the group of the 106 cases one patient had a pulmonary complication which delayed the patient's discharge until the twentieth postoperative day. All other patients were discharged on the twelfth to the fourteenth day. There were no wound infections. In the 6 patients in whom the operation was one of necessity all were discharged from the thirteenth to the twenty-ninth day.

Follow-up. Ninety-five patients or 85 per cent of those operated upon have been seen in the follow-up clinic one or more times. The duration of observation ranged from 2 to 30 months. All patients are usually seen 6 weeks after the operation and thereafter at bi-monthly intervals. Some patients have been seen only once, most of them on several occasions.

The results have been tabulated on an anatomical, clinical, and economic bases:

Anatomical: 67 patients had an absolutely negative pelvis; 17 patients had induration only;

5 patients had small masses; 6 patients had larger masses.

Clinical: 76 patients reported themselves clinically cured or asymptomatic; 13 patients had slight symptoms; 6 patients had definite symptoms.

Economic: 83 patients were able to perform their usual work; 12 patients had sufficient symptoms to interfere with work.

No patients have had to be re-admitted for severity of the symptoms or for a recurrence of a salpingitis. There have been no re-operations on account of pelvic disease. One patient who had a bilateral resection was re-operated upon 14 months later for intestinal obstruction. The obstruction was due to upper abdominal pathological conditions. A negative pelvis was found.

CONCLUSIONS

Cornual resection of the tubes is offered as a surgical procedure for the cure of recurrent gonorrheal salpingitis. It involves a minimum of surgical trauma and in 112 cases gave the following results: (1) no primary mortality; (2) no primary pelvic morbidity; (3) 70 per cent perfect, 14 per cent good, and 7 per cent fair anatomical results; (4) 79 per cent symptom free patients; 21 per cent with slight symptoms; (5) 87 per cent fit for manual labor; 13 per cent with only partial incapacity; (6) no re-operations for pelvic disease; and (7) no re-admissions for recurrent salpingitis.

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ENCAPSULATED INTRAMEDULLARY TUMOR INVOLVING THE WHOLE SPINAL CORD FROM MEDULLA TO CONUS: COMPLETE ENUCLEATION WITH RECOVERY

GILBERT HORRAX, M.D., F.A.C.S., and DONALD G. HENDERSON, M.D., Boston, Massachusetts

ALTHOUGH individual case reports are seldom of sufficient interest to warrant special and detailed tabulation, it so happens that occasionally a patient comes under observation with a condition so unique that one is urged from this standpoint alone to make a note of it, if for no other purpose than to put it on record in medical literature. Besides this, in the present instance we feel that there are at least 2 additional points to which attention should be drawn, namely, the possibility of doing an almost complete laminectomy and, secondly, the surprising extent of recovery of function following what amounted to a practically complete anteroposterior transection of the spinal cord throughout its entire length.

CASE HISTORY

A young woman, 29 years of age, was referred to The Lahey Clinic and the New England Deaconess Hospital on December 6, 1936, complaining of paralysis of the legs and difficulty with her bowels and bladder. The salient features of her past history were these: She had been admitted to a hospital in another city on September 18, 1930, at which time she had been having high, dull backache, and for one year was unable to use her legs. Because of her spinal symptoms lipiodol was injected and this was said to have shown a block in the upper dorsal region. Laminectomy was performed on September 29, 1930, at which time the cord was exposed from the level of the seventh cervical to the fourth dorsal vertebra. No pulsation was seen. The dura was opened and the cord appeared edematous. Nothing further was done, the dura and muscles were closed, and the condition was thought to be a myelitis. A cord bladder developed for which a suprapubic cystostomy was instituted.

The patient showed practically no change for about 1 year and then began to have some warning of micturition and a little motion in her legs developed. In January, 1932, the cystostomy tube was removed and she was able to void voluntarily. Gradually during the next 2 years the strength of her legs returned and in the spring of 1934 she resumed her former position as cashier in a theater. She was able to walk to and from her work, went to dances, and seemed perfectly well for about 1 year. During 1935 she again began having difficulty in walking and this increased to such a degree that by April, 1936, she was once more confined to a chair. On November 2, 1936, she was readmitted to the same hospital where she had been before, and was transferred from there to Boston. The results of her blood and spinal fluid Wassermann tests had been negative repeatedly.

When admitted to the New England Deaconess Hospital on December 6, 1936, she presented the following clinical picture: She was a well nourished young woman, lying in bed, without any great degree of discomfort. Cerebration was normal and her cranial nerves were normal throughout.

Motor system. Both legs were almost completely paralyzed although a very slight amount of extension at the knees was possible if the legs were held flexed by the examiner. Both arms and both hands retained fairly good strength, the left being slightly weaker than the right. There was some involuntary flexion of the thighs upon stimulation with a pin point over various areas of the legs or the dorsum of either foot.

Sensation. The patient showed a sensory level at the third rib anteriorly and the third dorsal spine posteriorly below which pain and temperature sensations were almost wholly lost, the loss of pain being the more complete of the two. There was marked hypo-esthesia to pain and temperature on the medial aspects of both arms and both hands. Light touch was fairly well preserved over the area just described, there being more diminution of this type of sensation over the lower extremities than the upper. Deep pressure pain was lost in the legs but was present in the arms. Vibratory sensation was lost below the hips, diminished in the left arm, and present in the right arm (Fig. 1).

Reflexes. All deep reflexes were bilaterally overactive except the Achilles jerks which were absent. There was at times a positive Babinski on the left but no sustained ankle clonus.

Sphincters. She had been having difficulty with voluntary control of both bowels and bladder, but this loss of function was not complete.

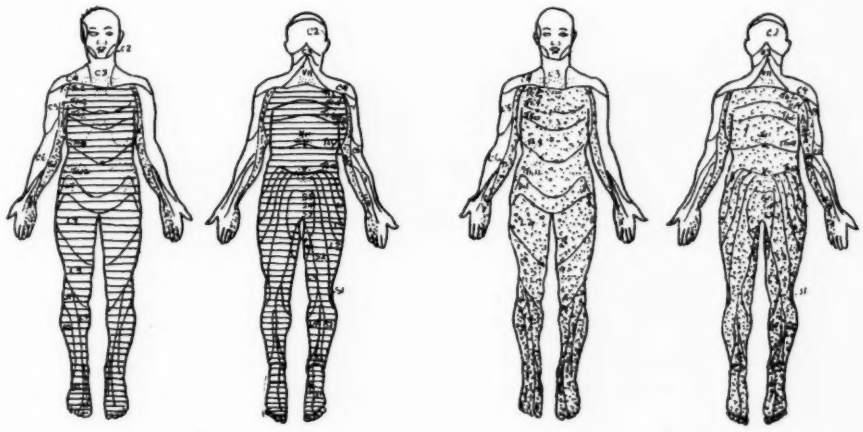
Lumbar puncture was carried out on December 9, 1936. The spinal dynamics showed a complete block. The lipiodol which had been injected previously could not be made to pass upward beyond the body of the eleventh dorsal vertebra.

Spinal fluid examination showed deeply xanthochromic fluid with a total protein of 1200 milligrams.

First stage operation, December 10, 1936. A cervicodorsal laminectomy was carried out, and the spines and laminæ from the axis to the seventh dorsal vertebra inclusive (the first to third dorsal had been removed at her operation elsewhere) were removed. Upon incision of the dura over this area the whole length of exposed cord appeared greatly widened and thinned out, the aspect being that of a huge cystic cord. The blood vessels on the surface were spread apart, and the cord had a grayish color. On the assumption that the condition was syringomyelia, a fine needle attached to a syringe was inserted into the widest part of the cervical region, but when suction was made no fluid was obtained.

The dorsal aspect of the cord was, therefore, incised in the midcervical region and at a depth of 2 to 3 millimeters

From the Department of Neurosurgery, The Lahey Clinic, and the Pathological Department of the New England Deaconess Hospital.



a b

Fig. 1. Chart showing the loss of various forms of sensation which the patient showed before operation. a, Pain and temperature; b, light touch. Horizontal lined areas analgesia; dotted areas, hypesthesia.

the surface of an apparently encapsulated intramedullary tumor was encountered. The growth was quite firm and of a brownish-gray color. The incision in the cord was now carried upward to the lower end of the medulla and downward to the inferior end of the dural opening. There was a tendency for the tumor to bulge through this incision. Growth could be separated from the attenuated cord on either side by gentle retraction and dissection with small moist cotton pledgets, and in this way it was followed upward to its superior pole at the lower limits of the medulla. When this upper pole was freed it could be grasped with a forceps and lifted outward, thus making it possible to peel the tumor out of its bed by gently brushing away the slightly adherent cord tissue below it. In this way it was enucleated down to the lower end of the cord incision at about the level of the fifth dorsal vertebra (Fig. 2). Here a silk ligature was tied around the growth and it was divided just above the ligature, the remaining tumor below this (of unknown extent at this time) being left to be taken out at a second stage operation, since the present procedure had lasted some 5 hours or longer. The patient on the whole was in very good condition although toward the latter part of the operation her blood pressure had dropped to about 80 millimeters systolic and 55 millimeters diastolic. She was given a transfusion of 250 cubic centimeters of blood.

The tumor was cylindrical and a little over 2 centimeters in diameter (Fig. 3). It almost bisected the cord anteroposteriorly so that along the anterior aspect of its bed there could be seen only 1 to 2 millimeters of cord substance and at some points only the pia and arachnoid had been left.

Second stage operation, December 16, 1936. At this session the spines and laminæ of the remaining dorsal vertebræ as well as the first and second lumbar were removed. After the dura was opened over this area the dorsal aspect of the cord was incised from the lower end of the previous operation down to the end of the conus, thus exposing the remaining portion of tumor which extended the entire length of the cord. This lower end of growth was peeled out in the same manner as at the primary operation. A portion of this lower end of tumor proved to be cystic but with a definite capsule, and not merely a syringomyelic cavity (Fig. 4). The cystic contents were first removed so as to gain room and make less damage to the cord; then the capsule of the cystic portion was grasped, lifted outward, and gently dissected free from its bed (Fig. 5). The dura and muscles were then closed in the usual careful layers.

Pathological report. The specimen consisted of 2 parts, roughly cylindrical, and its total length was 38.5 centimeters (Fig. 6). The upper piece had a diameter of 2.2 centimeters for a distance of 5 centimeters then gradually narrowed to 1.5 centimeters for the middle 19.5 centimeters. The lower portion of 14 centimeters was a thin walled, tube-like structure 0.5 centimeter in diameter

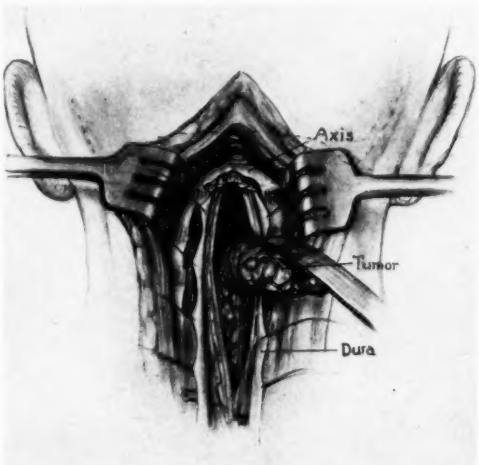


Fig. 2. Operative sketch of the first stage enucleation of the upper and larger portion of tumor.

Fig. 3.

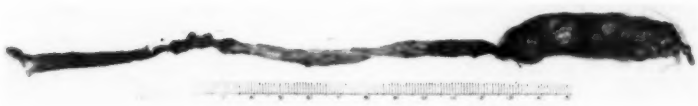


Fig. 4.

Fig. 3. Photograph (about two-thirds natural size) of the upper portion of tumor, removed at the first stage.

Fig. 4. Photograph (about ½ natural size) of the lower portion of tumor, removed at second stage. The narrow part is the cystic area from which the fluid had been evacuated.

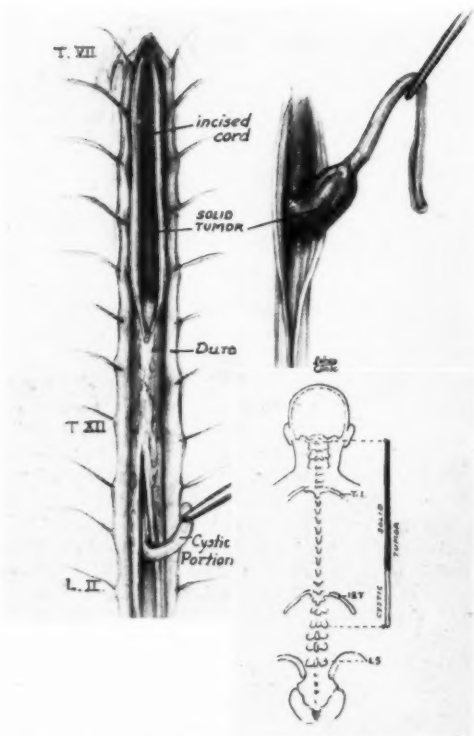


Fig. 5. Operative sketch, second stage, to show the method of enucleation of the tumor. Insert shows the extent of growth.

after removal. It was from this portion that the cystic fluid had been evacuated at operation, and when distended its diameter was fully equal to the upper end of the growth.

The tumor grossly had a delicate capsule, intact except for small foci of traumatic disruption. A surface network of hyperemic, fine blood vessels was apparent throughout and an occasional superficial, minute hemorrhage was noted. The upper 24.5 centimeters was soft, gray, and the cut surface showed the center softer and more hemorrhagic than the periphery. Delicate longitudinal striations were faintly visible in the deeper portions. The tube-like structure was collapsed; it had a smooth white lining, a homogenous elastic wall, and a finely shaggy surface.

Microscopically, with hematoxylin, eosin and phosphotungstic acid hematoxylin, the sections showed no definite capsule but surface layers that were interlacing and gave the appearance of being compressed. The bulk of the tumor was well vascularized. Large cells, having scanty cytoplasm and oval nuclei with heavy chromatin network, tended to arrange themselves about blood vessels; they were mostly unipolar with the processes extending toward the perivascular spaces (Fig. 7). Between these rosette-like regions, similar cells were growing solidly and an occasional bipolar cell could be determined. The stroma was scanty and blepharoplasts were definite but minimal. Mitotic activity was absent (Fig. 8). An occasional small, empty canal, lined by ependymal cells, was present, but that was a minor feature. Necrosis was absent. The lower sac-like portion showed both inner and outer lining surfaces to be composed of compressed, small cells having longitudinally interlacing processes, scanty cytoplasm, and oval, deeply stained nuclei. The wall was homogeneous and consisted of similar though larger cells. Microscopically the tumor corresponded to Kernohan's cellular type of ependymoma.

Postoperative course. The patient recovered promptly from each of her 2 long laminectomies. Her arms and hands were at first not as strong as they had been before operative intervention but they began to show improvement before she left the hospital. Likewise, by the time of her dis-

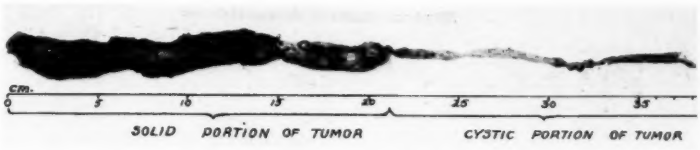


Fig. 6. Photograph of the entire tumor, pieced together.

charge she had begun to move the toes of both feet and the ankle on the right side, and slight flexion was possible at the right knee. She had regained the function of bowels and bladder which had been lost completely after operation, and was up in a chair several days before leaving. On January 30, 1937 she was discharged to her home, 6½ weeks after her second operation (Fig. 9).

Follow-up notes. The patient has reported from time to time by letter indicating her progress. She has slowly regained almost full use of her right hand and both arms but the left hand is still somewhat weak. Both legs regained strength slowly, and on June 2, 1937, 6 months after operation, she was able to stand with support. Her back has never given her any trouble from weakness. By July 13, 1937, she was able to take a few steps with support and her letter of October 4, 1937, stated that she was standing and taking steps with support every day, the right leg being much better than the left. Her last letter, February 2, 1938, 14 months after operation, was most encouraging. To quote: "I walk every day with help on each side of me. The right leg is wonderful. I think it is almost back to normal (Fig. 10). The left leg has to be pushed along but sensation seems to be better all through the left side."

DISCUSSION

A fairly complete review of the literature has revealed only 2 instances of intramedullary tumors, which were encountered at operation and removed, at all comparable in size and length to that of our patient. The first of these was reported by Cushing in 1927.

This tumor was an ependymoma in a girl 8 years of age, and it extended from the medulla to the second thoracic level. The dorsal aspect of the cord was incised as in our case and the growth, which was soft, removed by suction. At this first operation a laminectomy from the atlas to the second thoracic vertebra inclusive was performed. Thinking that the tumor extended below this lower level, a second stage operation was carried out removing the remaining thoracic and the first 2 lumbar laminæ. Only a hydromyelic cavity, however, was found throughout this lower end of the cord. The child made an excellent recovery, and was practically normal for 5 years.

The other instance in which a long intramedullary growth was operated upon was Case 3 reported by Foerster and Bailey in 1936. The tumor extended from the first cervical to the ninth thoracic level. It was removed piece-meal at operation, but unfortunately the patient died the following day. The tumor was an astrocytoma.

Several instances of long, intramedullary growths, which were discovered at necropsy, are quoted by Foerster and Bailey in the important article in which they report their own experiences. These are the cases of Hatschek, a myxoglioma of the entire cord; of Miura, a glioma extending from the midcervical to the lower lumbar region; of Nonne, a sarcoma involving the first cervical to the tenth dorsal segments; of Schueppel, a gliomyxoma extending from pons to conus; of Schultze, a gliosarcoma from bulb to conus; of Taterka, a fascicular glioma from bulb to the twelfth thoracic

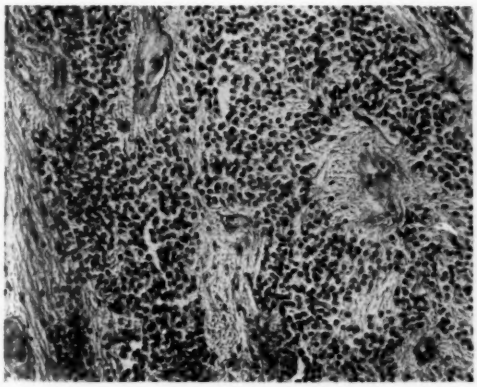


Fig. 7. Photomicrograph of characteristic area of tumor. Note the uniform type of cell with rosette-like formations around the blood vessels. ×100.

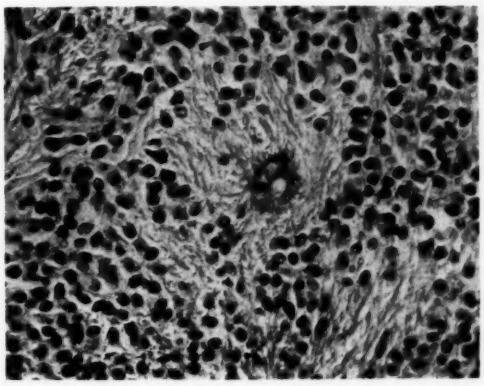


Fig. 8. Photomicrograph of a section of the tumor which again shows the rosette-like formation and absence of mitoses. ×150.

Fig. 9. Photograph of operative scar at the time of the patient's discharge.

Fig. 10. Snapshots of the patient at her home, March 16, 1938.

vertebra; of Thielen, a neuro-epithelioma gliomatosum from the upper cervical region to the conus; and of Zinn, another neuro-epithelioma gliomatosum from the first cervical to the conus.

The second question which would seem appropriate to discuss in connection with the case reported here has to do with the actual operation performed. The propriety of removing intramedullary tumors completely has been questioned, since at times more damage may be done to the cord by radical removal than would have been the case had the dorsal columns merely been incised, the tumor allowed to extrude partially, and then more or less completely removed at a secondary operation. This method was advocated by Elsberg in 1925 and doubtless has its advantages in soft infiltrating tumors. Furthermore, it has been held as almost axiomatic that an attempt to extirpate intramedullary growths involving the fourth cervical segment should not be made because of the grave danger of respiratory cessation.

So far as both these questions are concerned there is now considerable evidence in the literature, including our own case, to make us believe that in the encapsulated tumors such as the ependymoma here reported, a careful complete extirpation no matter what the level, is the procedure of choice. This attitude is taken by Kernohan, Woltman and Adson (6), and reemphasized by Adson (1935) in his discussion of the important paper by Kernohan and Fletcher-Kernohan (7). Mention has been made already of the patient operated upon by Cushing in 1927 in which no untoward feature occurred during the removal of the cervical portion of an extensive ependymoma. Other cervical intramedullary growths which have been extirpated radically without serious repiratory upset were reported by Cairns and Riddoch (1931); by Adelstein and Patterson (1934); and by Foerster and Bailey (Case 7) 1936. On the other hand in Case 4 of Foerster and Bailey death was caused by respiratory paralysis.

An interesting point in reviewing our own case comes out in the extraordinary relief of symptoms which the patient obtained after her original small exploratory laminectomy in 1930. It will be remembered that at this time the dura under the upper 3 thoracic vertebræ was opened, the cord inspected, and the dura again closed. She remained paraplegic for approximately a year, then gradually improved for 2 years and during the year 1934 she resumed her usual work, walking about, going to dances, and so forth. It is difficult to explain this improvement on the basis of the operation, but it may be that during the ensuing year there was sufficient atrophy of the vertebræ by pressure from the tumor to give a spontaneous decompression to the cord.

At the time of our operation patient was paraplegic with beginning sphincteric incontinence.

It might be asked whether merely splitting the whole length of the cord posteriorly and leaving the dura open might not have given her more prompt and complete recovery than she has shown up to the present time. This is a possibility, but in that case she would still retain her tumor and at some future time would have to undergo the same extensive operative procedures with perhaps even greater technical difficulties than at the original session. It does not, therefore, seem to us that such a course would have been advisable.

Another subject which should be mentioned is the ability to recover from a complete anteroposterior transection of the spinal cord. In our own patient this transection was complete in certain places in the cervical region where only the pia arachnoid was visible anteriorly, and throughout the entire cord there were probably only 1 to 3 millimeters of cord substance remaining anterior to the tumor. As told in the patient's follow-up reports, she has recovered the motor function of her right leg almost completely; but sensation is poor in this leg, whereas with the left leg the reverse is true. In Foerster and Bailey's Case 3 a similar complete transection was made, but the ability to recover could not be followed up owing to the death of the patient within 24 hours. No mention was made as to the completeness of the spinal cord transection in the other cases which have been reviewed.

From the pathological standpoint the incidence of primary ependymomas to other intramedullary spinal cord tumors has not been accurately determined, but in a series of 51 cases Kernohan, Woltman and Adson found that they represented 42 per cent. Of the gliomas in the region of the cauda equina the incidence rises to 68 per cent (8). This type of tumor is relatively slow growing and has not been observed extending outside nervous tissue. The sections of the specimen reported here show no definite capsule, but the compressed surface layers, lack of mitotic activity, and presence of well differentiated cells, all indicate low invasive tendencies.

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ACUTE FRACTURES OF THE CARPAL SCAPHOID

RUSSELL F. JAEKLE, M.D., and ALBERT G. CLARK, M.D., San Francisco, California

IN handling a large number of fractures during the construction period at Boulder Dam we were quite interested in observing that our percentage of fractures of the carpal scaphoid was high as compared to other bony injuries about the wrist. The statistics regarding the percentage of these fractures reported by other authors have varied considerably, but we feel that our statistics may be considered as typical for purely industrial practice.

A comparison of fractures of the carpal scaphoid with other more common fractures is given herewith: carpal scaphoid 17; humerus 25; radius 63; clavicle 16; femur 21; tibia 85; fibula 78; os calcis 43.

The literature on this subject is somewhat disconcerting. Cravener, reporting on fractures of the carpal scaphoid, states that non-union is very prone to occur in fractures through the waist, while fractures through the tuberosity are of relatively little importance. Murray states that fractures of the tuberosity always unite satisfactorily and that fractures through the waist, if immobilized early, will also give satisfactory results. Both of these authors are inclined to believe that non-union is due to delayed immobilization. Boehler also reports satisfactory results with immediate fixation. Hosford agrees with the above authors on the results obtained with immediate immobilization, except he states that fractures through the proximal third of the bone have a tendency to non-union due to the interference with the blood supply. Scudder is more radical, recommending total excision of the involved bone whenever there is a comminuted fracture. When immobilization without open reduction is done, it is generally advised that this immobilization be maintained for a period of 6 to 8 weeks. Almost all positions have been advised for the immobilized wrist. Boehler recommends dorsal ulnar flexion. Speed recommends a slight volar and radial flexion, and Soto Hall and Haldemann advise a dorsal radial position. As far as reported results are concerned it is difficult to arrive at any definite conclusions because of the fact that the final results are not uniformly rated but are merely said to be good, fair, or poor. This type of information is not always helpful.

From the fracture service, Six Companies Hospital, Boulder City, Nevada.

DIAGNOSIS

The history of these cases is that of a fall on the hyperextended hand with resultant pain and some swelling in the wrist at the base of the first metacarpal. It can be unequivocally stated that any painful or so called sprained wrist occurring after a fall on the outstretched hand should always be x-rayed. On physical examination we have almost always found tenderness and occasionally swelling in the anatomical snuff box. Motion of the wrist is not limited except by moderate pain. Many authors have reported that the diagnosis is confirmed by percussion on the head of the second metacarpal when the fist is clenched. This is supposed to elicit pain in the region of the scaphoid. Frankly, we have never used this test and have always found the diagnosis to be easy enough, provided the possibility of such a fracture has been considered.

It has also been mentioned frequently that the x-ray is not infallible. It is particularly misleading when one simply has an anteroposterior view and a lateral view made such as one would desire for a possible Colles' fracture. It is advisable to take at least one view with the wrist ulnar deviated, and in questionable cases, a stereoscopic view should be taken with the wrist in this position. Some roentgenologists advise the use of a magnifying lens when studying these films. Wet films should never be used in determining the presence of these fractures. In the final analysis we believe that, if the physician calls the attention of the roentgenologist to the possibility of a fractured carpal scaphoid, these fractures will not be missed frequently on the x-ray plate.

TREATMENT

The results of treatment of any fracture are enhanced by (1) early recognition, (2) early treatment, and (3) adequate immobilization for a sufficient time to allow healing. Because of the nature of cancellous bone (its location, structure, and blood supply) when fractured, it is difficult to obtain healing and these factors assume increased importance.

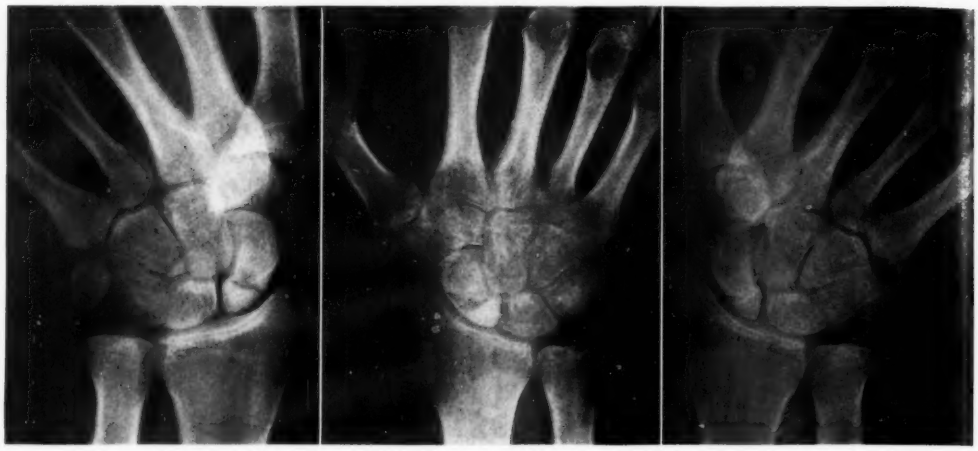
We have nothing new to offer in treatment but only wish to emphasize the important part early treatment has played in our results. Because of an ideal setup for medical care at Boulder Dam, our patients were almost always seen within the

Fig. 1. a, left, Fresh fracture; immobilization in non-padded plaster for 6 weeks; time off from work 8 weeks. b, Appearance after 6 weeks.

first hour after injury. Early recognition and treatment thus being made possible, open reduction of any fractured bone was the exception, because of the ease of closed reduction in an early case. We maintain that the practice of waiting overnight or days later to accomplish a reduction is a serious mistake and conducive to unfavorable results. The newer school advocates open operation with bone graft inlay for these fractures and reports good results in all cases. About one third of this series of scaphoid fractures were simply immobilized upon cock-up splints in a position of moderate dorsiflexion and slight radial flexion. In the latter two thirds we applied unpadded plaster casts with the wrist in the same position, and with the thumb fully abducted and incorporated in the cast. The plaster extended only to the distal palmar crease, thus allowing full movement of the fingers. The fact that end-results in all cases were the same argues for the belief that early treatment is the keynote, not the method nor the fixation in any exaggerated position. There can be no question concerning the efficiency of unpadded plaster in satisfying the third requirement of adequate fixation. Immobilization was generally maintained for 6 to 8 weeks depending upon the extent of healing shown by x-ray examination, although our results show the average entire compensable time to be 6.62 weeks. In 2 cases the patients were foremen and returned to work in 9 and 16 days respectively, while 2 others returned to light work as watchmen in 2½ and 3½ weeks, with their casts on and still under treatment. The average length of treatment was about 10 weeks.

Roentgenograms were taken at the time these men were rated by the Industrial Accident Commissions of Nevada or Arizona, usually 3 to 4 months after they had returned to work. Only 2 of the 16 failed to show bony union. The criteria for bony union were complete obliteration of the fracture line, with the proximal fragment showing the same density as the distal. One of the 2 cases of non-union had also a comminuted fracture of the radius and a fractured hamate. After reduction the wrist was held in slight palmar flexion and in a mid position between ulnar and radial deviation with the thumb partially adducted. This would seem to indicate the importance of position in healing of the scaphoid, if it could be shown that position alone brings as high a percentage of bony union. We have had experience with only one old non-union of a scaphoid. This was seen by one of us in private practice.

The patient, one year after the original injury, complained of a painful wrist. He was doing his regular work, but felt that he could not do it as well as he had previously. Tenderness and slight swelling were present in the anatomical snuff box and x-ray films showed a fracture of the proximal third of the scaphoid with some cystic rarefaction about the site of the fracture. The apposition and alinement of the fragments were good. After the method described by Haldeman and Soto Hall, horizontal incision was made over the scaphoid which was exposed. Several drill holes were made through the fragments, the wound was closed, and a non-padded plaster cast was applied with the wrist in the dorsal ulnar position. This cast was left on for 14 weeks and the patient was returned to light work 2



a b c

Fig. 2. a, Non-union of fracture 1 year old. b, Appearance, 10 weeks and, c, 30½ weeks after drilling. Patient's wrist was in non-padded plaster 14 weeks and he was away from work 16 weeks. No disability. Note fracture line disappearing and the gradual return of blood supply as evidenced by decreasing density of the proximal fragment.

weeks later. Bony union was partially completed when the last roentgenogram was taken 6½ months after the operation. The patient has full range of motion of the wrist and has no subjective complaints.

RESULTS

From a practical standpoint the results were perfect in all cases, since there was a normal range of motion, without pain, and with full strength of the wrist when these men were rated. Uniformly there was no permanent disability award. The average time lost from work was 6.62 weeks which is less than we would allow for any individual case without the exceptions here noted.

In sharp contrast to the conservative treatment, we present one case treated in the hospital by another surgeon. In this case, radical excision of the fragments was done. This patient was on total temporary disability for 8 weeks, and returned to a foreman's job, requiring only moderate use of the hand. Eventually he was rated at a 35 per cent loss of function of the hand.

It is difficult to compare the results offered by different authors because of their various ways of reporting such results. We believe that inasmuch as the majority of these cases are industrial, are treated by industrial surgeons, and are finally rated by industrial accident commissions they should be reported by the disability rating awarded. This, in turn, would make these reports a basis for both the insurance carriers and the industrial surgeons to use in making a preliminary estimate of possible resultant disability in any particular type of fracture. We realize that different accident commissions and medical referees will report in different degree on the same disability. But in general we believe that experienced commissions and referees will not vary appreciably in their decisions. We also realize that in fractures of bones when considerable variation in the type of injury may occur, the disability will vary accordingly.

In a previous paper, however, which considered fractures of the os calcis, we attempted to show that the type of injury and fracture may be so classified that a fairly accurate idea of the resulting disability could be estimated upon a preliminary examination of the injury and of the first roentgenograms, provided a certain line of treatment were carried out. Fractures of the carpal scaphoid are not so varied as to require any classification. Although we know that we may obtain fractures of the tuberosity, fractures of the waist, and fracture dislocation of the scaphoid, we find no need to classify these separately because the results, with proper and immediate treatment, have been uniformly good. Where poor results are obtained, namely, painful non-union, we are inclined to believe that they were caused by delayed immobilization as a result probably of delayed diagnosis.

The economic value of this survey means that, for any individual case, with early recognition, and

immobilization in the accepted position with unpadded plaster for 7 to 8 weeks, one can expect no total permanent disability and 87½ per cent of bony union.

These results in acute fractures and in the one old case of non-union which we report, plus the numerous other excellent results obtained in the treatment of old non-unions by drilling or grafts, we believe should definitely contra-indicate excision of the carpal scaphoid under any condition.

CONCLUSIONS

1. Immediate immobilization is stressed.
2. Failure of bony union occurred in only 2, or 12½ per cent of the acute fractures.
3. Disability ratings in the acute fractures, including the 2 cases lacking bony union, have been uniformly zero.

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INTRAPERITONEAL HEMORRHAGE FROM RUPTURED OVARIAN RETENTION CYSTS

Corpus Luteum and Graafian Follicle Cysts

FRANKLIN I. HARRIS, M.D., F.A.C.S., and MORRIS J. GROPER, M.D.,
San Francisco, California

DURING the last few years rupture of ovarian retention cysts has received more frequent recognition in the differential diagnosis of acute surgical abdominal conditions. The consideration of this diagnosis as to its importance had not been emphasized previously. The description of characteristic clinical symptoms produced by a rupture of an ovarian retention cyst is difficult to find in any textbook or current surgical literature. Cope, in his excellent and adequate work on the diagnosis of the acute abdomen, does not mention this subject. Individual case reports are frequently noted and a few papers have appeared covering larger series. To date a total of 367 cases have been reported in the literature. This condition is not the rarity is was formerly thought to be, but its recognition and pre-operative diagnosis still remain difficult.

In an attempt to classify the clinical picture of this surgical entity, the authors have reviewed a series of 45 patients with ruptured ovarian retention cysts who were admitted to the surgical service of the Mount Zion Hospital during the years 1926 to 1938. The study of this group of cases has shown remarkable variations in the pathology, the clinical diagnostic features, and the etiology. The one characteristic feature of all these cases, however, has been the constant finding at operation of intraperitoneal hemorrhage in varying amounts. It is our belief that the variations in the pre-operative picture are directly dependent upon the severity and degree of intraperitoneal bleeding, and that a clinical classification with adequate features may be described on this basis.

PHYSIOLOGY AND PATHOLOGY

To understand properly the clinical course of a ruptured ovarian retention cyst, it is essential to review briefly the normal physiology of ovulation and the deviations which result in pathological ovarian cyst formation. Without attempting to describe the minute histology of the ovary, it is sufficient for our purposes to review the normal sequence of events connected with ovulation. The ovarian stroma contains an innumerable number of primordial cells which vary greatly in degree of maturity. As an individual ovum matures it is seen to be deeply situated within a cyst-like structure lined by granulosa cells, first described by de Graaf and now referred to as a graafian follicle. It is generally considered that during the middle of the menstrual cycle the matured graafian follicle ruptures to expel the ovum. The follicle fills with blood and fibrin, and the granulosa cells are transformed to large luteal cells as organization proceeds. Later the corpus luteum shrinks in size and terminates as an orange pigmented scar.

The graafian follicle and corpus luteum found in this normal process are minute structures hardly visible to the naked eye, and it is improbable that clinical disturbances of surgical significance are produced in this cycle. If hypersecretion into the graafian follicle occurs at some stage in its development, a pathological condition results which produces an abnormal enlargement of the follicle, so that there occurs a cyst formation which has been called a graafian follicle cyst. Failure of the corpus luteum to regress and disappear might likewise result in the formation of a cyst which is referred to as a corpus luteum cyst. In such a cyst the wall may be 1 to 3 centimeters in thickness so that the cavities vary proportionately. Occasionally, the ovary may be completely replaced by the cyst although a small nodule of ovarian parenchyma remains near the pedicle.

Basically, both these types of cyst have the same origin. Microscopically, they differ slightly in their structure. For simplicity in their clinical classification as well as to describe their common origin, they may be referred to as ovarian retention cysts (5). We advocate the use of this terminology for clinical discussion on this subject. There appears to be considerable confusion in the literature in reporting these cases as to whether the author is describing a rupture of a corpus luteum or graafian follicle cyst. This differentia-

From the Surgical Service of Dr. Harold Brunn, Mount Zion Hospital.

tion is insignificant in relation to the surgical aspects of this entity. In this series corpus luteum cysts comprised 75 per cent of cases and the follicle cysts 25 per cent.

SURGICAL PATHOLOGY

The occurrence of intraperitoneal hemorrhage arising from ovarian retention cysts is now well established. The usual findings of a gross tear or rupture in the wall of these cysts explain in most cases the origin of the hemorrhage. In such instances the cyst cavity usually contains blood which may be clotted and around which a small steady ooze or a larger spurting vessel may be found. In some cases it is impossible to demonstrate the vessel from which the bleeding occurs, and the opening on the surface of the ovary may be so minute as to leave one in doubt as to the ovarian origin of the intraperitoneal hemorrhage. This is not surprising since nature attempts to wall off the troublesome area and lay down a zone of fibrin so as to close the point of hemorrhage.

VerBrugghen reports a case of massive intraperitoneal hemorrhage wherein at operation he found a small bleeding point on the right ovary. Although the abdominal cavity was thoroughly explored, no other point of hemorrhage could be found. The surgeon in this instance felt that the minute point of hemorrhage in the ovary did not explain the massive intraperitoneal bleeding. In 2 of our patients, one of whom was almost exsanguinated, no point of rupture could be seen although the assumption was made that the hemorrhage came from a cystic ovary filled with blood. It was removed and the pathologist proved it to be the source of the hemorrhage although he was unable to demonstrate a point of rupture. Apparently a massive intraperitoneal hemorrhage may take place as the result of a small tear in one or the other type of ovarian retention cysts, and no point of rupture may be demonstrable even by microscopic examination.

Emil Novak states that the occurrence of hemorrhage will depend largely on the location of the rupture of the cyst structures in relation to its blood vessels. If they lie near the surface when it ruptures, an extensive hemorrhage will then result; whereas a rupture in a relatively avascular area might produce very little bleeding. Our series confirms this statement.

Occasionally, these cysts may produce an abnormal type of vaginal bleeding which is on a hormonal basis. We refer to the vaginal spotting which is sometimes seen and simulates the spotting associated with ectopic pregnancy. Such bleeding is most likely explained on the basis of an excess of estrin secreted by the abnormal cyst. There is proof offered by various writers that a follicle cyst may secrete an excess of estrin (7, 8). One of the actions of estrin is to produce an increased vascularity of the uterine endometrium which may produce continuous spotting. This was noted in 4 of our cases and suggested tubal pregnancy. In one of the cases the spotting continued following the resection of the cyst but stopped on the administration of prolan in the form of antuitrin-S.

Fig. 1. Photomicrograph of graafian follicle cyst removed from Case 2, Mrs. B.L. Section shows multiple follicle cysts without hemorrhage and a large central cyst filled with blood. This larger cyst had ruptured producing a moderate hemorrhage simulating acute appendicitis.

THEORIES AS TO MECHANISM OF RUPTURE

In discussing the mechanism of rupture in these cysts, the question arises as to whether spontaneous intracystic bleeding is a forerunner to rupture, or whether bleeding is the result of rupture produced by other extracystic factors. Theoretically, it is conceivable that hormonal influences might play a part in the production of spontaneous bleeding into these cysts. The general increased vascularity of the pelvic organs at such a time may easily explain the intracystic hemorrhage and subsequent rupture. The occurrence during sound sleep of a rupture, which is not infrequent, can be

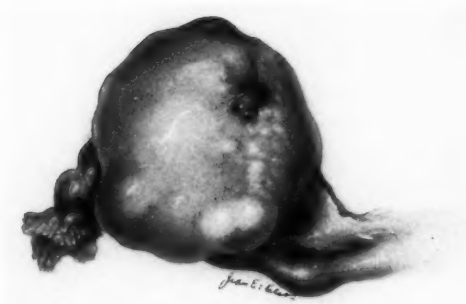

Fig. 2. Drawing from specimen removed at operation from Case 32, Mrs. S.R. Pre-operative diagnosis of ectopic pregnancy. Drawing shows point of hemorrhage that is sealed over by fibrin and a large thick walled corpus luteum cyst which grossly simulated an ovarian pregnancy.

Fig. 3. Photomicrograph of specimen shown in Figure 2. The corpus luteum is a thick walled cyst with the center of the cyst filled with old and recent hemorrhage. There is moderate edema of the ovarian stroma.

explained only on the basis of spontaneous intracystic bleeding. This has been noted in this series as well as in other reports.

In the majority of these cases, however, there is usually a history which suggests a more than casual relationship to some exciting traumatic factor. Most authors have, therefore, assumed that the rupture precedes and is the cause of the bleeding. Our series demonstrated a high percentage of the cases wherein the history suggests extracystic factors of the type of direct or indirect trauma.

In this category we place cases which are antedated in the occurrences of their symptoms by a history of: (1) a pelvic examination; (2) a direct blow on the abdomen; (3) coitus; (4) straining at stool, lifting heavy objects and vomiting, as examples of increased intra-abdominal pressure; (5) acute appendicitis and appendiceal colic are occasionally etiological factors probable on the basis of the pain associated with these conditions increasing intra-abdominal pressure.

CLINICAL ASPECTS

The degree of intraperitoneal hemorrhage determines the characteristic clinical features of this condition. This study of 45 cases suggests the division for descriptive purposes into 3 groups: (1) those suffering from mild hemorrhage by which is meant the finding at operation of an amount of blood or blood tinged fluid of less than 100 cubic centimeters; (2) those suffering from moderate hemorrhage amounting to between 100 and 500 cubic centimeters; and (3) those suffering from massive hemorrhage of from 500 to as much as 1500 cubic centimeters.

Group 1 is characterized by mild intraperitoneal bleeding with minimal symptoms. In this group the pain is extremely variable and depends on various factors. There may be a history of a sudden sharp pain of momentary duration in either the right lower quadrant or the left lower quadrant which is due to the actual rupture of the cyst. This momentary pain may be followed by complete relief. A few hours to a few days later there may be noted the appearance of vague lower abdominal pains which are fleeting and ill defined. The patient is not sick enough to be confined to bed but has a definite feeling of discomfort in the lower abdomen. These patients are often admitted to the hospital for observation on suspicion of a possible acute surgical abdomen, and are discharged within 24 to 72 hours because of lack of further positive findings. Occasionally they are returned in another 48 to 72 hours for exploratory operation due to the persistence of these vague abdominal pains. Shoulder pain has not been noted in this group. Nausea of mild degree is occasionally present but vomiting is seldom seen. Symptoms of mild shock are absent.

The history of the onset of these symptoms can always be traced to a definite relationship with the menstrual cycle, and is of the utmost significance. Pain occurring in the lower abdomen at or after the middle of the intermenstrual period suggests probable follicular origin. Pain appearing just preceding the onset of the menses is due to hemorrhage from a corpus luteum cyst.

On examination one is impressed by the fact that these patients do not appear sick. There is no change in the pulse or temperature. Muscle guarding may be present but is not well defined or constant, and true rigidity is never seen. Tenderness is present at some time during repeated examinations on such a patient but may be absent at other times. It is not pronounced and when felt is always in the lower abdomen. Auscultation of the abdomen shows normal or slightly increased peristalsis.

Pelvic examination may occasionally show the presence of a small cystic protuberance in one or the other ovary. When such positive findings are present and the patient is conservatively treated, check-up examination after the disappearance of the symptoms may reveal normal ovaries with no evidence of the cyst previously noted.

The blood count in the mild cases usually shows essentially normal findings. No anemia is noted and leucocytosis is not the rule although an occasional case has shown a rise in the white blood count to as high as 15,000.

GROUP 1: ILLUSTRATIVE CASES OF MILD HEMORRHAGE

Mrs. S. N. (No. 22834), age 24 years, entered the hospital on April 9, 1936. She was complaining of pain in the lower abdomen of 4 days' duration. The pains were described as being originally referred to the pit of the stomach and were not severe. The last 2 days they had centered in the lower abdomen. There was no history of vomiting but she had noticed occasional slight nausea. Her last menstrual period was approximately 2 weeks before on March 23, 1936.

Examination showed a patient apparently not sick looking, temperature 37 degrees C., pulse 80. On examination of the abdomen there was found tenderness in both lower quadrants. No rigidity was found but there was slight muscle guarding present. There was no distention of the abdomen and peristalsis was active. A pelvic examination showed tenderness in both fornices but no masses were palpable.

Laboratory work: White blood count, 10,400; polymorphonuclears, 69 per cent; hemoglobin, 79 per cent; red blood count, 4,200,000.

A tentative diagnosis of subacute appendicitis was made. At operation approximately 100 cubic centimeters of blood tinged fluid was found in the pelvis and there was a cystic right ovary with a rupture of a small cyst about the size of a cherry which was still oozing blood. The appendix was essentially negative.

This case illustrates a time interval of 4 days from onset of the pain to the time she sought medical advice. The persistent indefinite abdominal pains made the surgeon suspicious of appendicitis. The onset of her pain, approximately 2 weeks after her last period, suggests that it was a rupture of a follicle cyst, although the surgeon described it as a ruptured corpus luteum cyst. The common error of diagnosing subacute appendicitis is also illustrated by this case. Had the exact diagnosis been made the patient would probably not have needed surgery.

Mrs. O. M., age 23 years, entered the hospital on November 14, 1937. She stated that immediately following the act of defecation early that morning she was seized with a cramp-like pain that doubled her up. This pain lasted about 1½ hours and was located deep in her lower abdomen. There was no nausea, no vomiting, nor had she felt faint or dizzy. Her last menstrual period was about 3 weeks previous. She stated that she expected to menstruate in a few days.

Examination showed a patient who did not appear sick; temperature, 37 degrees C.; pulse 96. The abdomen showed tenderness in the right lower quadrant and suggestive rebound tenderness over McBurney's point. There was moderate muscle guarding but no true rigidity and peristalsis was very active. Pelvic examination showed a suggestive tender cystic mass in the right fornix.

Laboratory work: White blood count, 7,300; polymorphonuclears, 79 per cent; red blood count, 3,860,000.

Subsequent course: In 36 hours the abdominal pains completely disappeared. The patient was discharged from the hospital with a diagnosis of a ruptured corpus luteum cyst. She was examined in the physician's office 10 days later and the cystic mass noted in the right fornix had disappeared although the ovary could be easily palpated.

This case illustrates the suddenness with which the onset of the pain appeared in relation to the act of defecation, suggesting a rupture of a retention cyst. Because of the proximity of her next menses the cyst was probably a corpus luteum. She was treated conservatively with complete relief and the disappearance, on subsequent pelvic examination, of the cystic mass found during the acute attack.

Group 2. The onset of pain is not unlike that described in Group 1, and bears a similar relationship to the menstrual cycle. Usually there is a history of sudden sharp pain in the lower abdomen but the duration following the onset is longer. Although there may be a cessation of symptoms for a period of hours, the return of pain within a short time is the rule. The pain is more definitely localized to either the left lower quadrant or the right lower quadrant and simulates more closely the pain of acute appendicitis, particularly pelvic appendicitis, when localized to either the left lower quadrant, as Brunn has so well described. On continued observation the pain shifts to the upper quadrant of the abdomen but is not colicky in nature and is described as a severe discomfort. Seldom is a narcotic required. When questioned many of these patients will recall or complain of pain in one or the other shoulder which is pathognomonic of the presence of sufficient blood to cause diaphragmatic irritation. Nausea is noted as frequently as in Group 1, and vomiting is occasionally present but is not noteworthy. Symptoms of mild shock are noted in many

patients and are characterized by dizziness, faintness, and a feeling of weakness. These symptoms are particularly pronounced if the patient has been ambulatory.

On examination these patients appear worried and somewhat sick looking. No noticeable alteration in pulse or temperature is observed. Abdominal tenderness, however, is a constant finding. It is limited to the lower abdomen but shifts to the upper quadrants frequently. This shifting tenderness is strongly suggestive of moderate intraperitoneal bleeding. The tenderness may be quite exquisite, particularly in the inguinal regions. To the experienced surgeon it is not, however, the abdominal tenderness of an acute infectious peritonitis. Muscle guarding is pronounced and in most of these cases may even suggest true surgical rigidity. On auscultation peristalsis is very active and will help in differentiating from the *silent abdomen* of more serious conditions. Pelvic examination may or may not reveal a palpable cystic mass in either one ovary or the other. Occasionally however, a doughy fullness may be felt in the cul-de-sac suggestive of an accumulation of blood or blood clots. The blood count is quite variable with a greater tendency to leucocytosis. No change is noted in the hemoglobin of sufficient importance to be of clinical value.

GROUP 2: ILLUSTRATIVE CASES OF MODERATE HEMORRHAGE

Miss M. E., age 20 years, a graduate nurse, entered the hospital on January 26, 1935, stating that early that morning she was awakened from her sleep by a sharp severe pain in the lower abdomen which seemed more intense in the right lower quadrant. She became very nauseated but did not vomit. Her last menstrual period was approximately 3 weeks previous.

On examination the patient appeared sick and worried; temperature 37.3 degrees C., pulse 84. The abdomen showed no rigidity but there was marked tenderness over the entire abdomen particularly more pronounced over McBurney's point. Auscultation showed very active peristalsis. There was mild muscle guarding over the entire abdomen.

Laboratory work: White blood count, 7,480; polymorphonuclears, 68 per cent.

After 24 hours' observation the clinical picture had not changed; the abdominal pains, although varying considerably in severity, were still present. As her tenderness seemed definitely localized to the right lower quadrant a diagnosis of acute appendicitis was made and surgery advised. Operation was performed through a McBurney incision and when the peritoneum was opened a considerable amount of bright red blood was found. A normal appendix was quickly removed through this incision and it was then closed and a midline incision made. On exploration of the abdomen approximately 500 cubic centimeters of bright blood was seen and a ruptured cyst, the size of a walnut, was found still oozing blood from the left ovary. The cystic portion of the left ovary was resected and plastic closure of the remaining stroma made with interrupted silk sutures. The patient's convalescence was uneventful.

This case illustrates a more severe type of pain simulating appendiceal colic. The diffuseness over the abdomen on continued observation and the active peristalsis without a rise in temperature or white blood count after 24 hours should have made one suspicious that the diagnosis was not acute appendicitis.

Mrs. M. O., age 25 years, a housewife, was seen at home on November 27, 1936. Of interest in her past history is that she had her appendix removed at the age of 15. The patient stated that for the past 3 days she had had indefinite pains in her lower abdomen which were similar in nature to the pains she remembered having during her attack of appendicitis a few years previous. She said the pain disappeared and reappeared and in the last 24 hours had increased in severity so that she felt it advisable to remain in bed. She also complained of slight dizziness and weakness when she was on her feet. On direct questioning she complained of pain in her right shoulder.

Abdominal examination showed a soft abdomen with tenderness in all quadrants particularly in the right lower quadrant. There was no rigidity nor muscle guarding and active peristalsis was heard. Pelvic examination showed the right ovary to be enlarged with a suggestion of a small cystic mass attached to it which was very tender. Her last menstrual period was 2 weeks previous.

A tentative diagnosis of a ruptured follicle cyst was made and the patient was advised to remain in bed with ice packs to the lower abdomen. She made a complete recovery in about 3 days and reported to the office for a check-up pelvic examination on December 14, 1936, at which time no evidence was found of a cystic mass attached to the right ovary nor was any tenderness present.

This case illustrates a classical picture of a ruptured follicle cyst. The previous removal of her appendix aided in the diagnosis. Characteristic right shoulder pain suggestive of moderate intraperitoneal hemorrhage and the finding of a cystic mass connected to the right ovary which disappeared over the subsequent period of observation was further confirmation. Such a case affords one, who has a "high index of suspicion," a fine opportunity of studying the progress of ruptured ovarian retention cyst under conservative management.

Group 3. These patients show signs and symptoms which are typical of massive intraperitoneal hemorrhage. They constitute the smallest percentage. The onset of the pain is definitely more severe and constant in its character. There is no period of relief, rather an increase in its severity. The pain is localized across the entire lower abdomen but in a few hours it involves the upper abdomen and there is characteristic pain in either one or the other shoulder. Nausea is more frequently seen, as well as vomiting. These patients show definite evidence of shock which may be profound. Abdominal tenderness is generalized

with maximum tenderness in the lower abdomen. Muscle guarding is definite but no rigidity is noted. Peristalsis in this advanced bleeding type may also be absent. On percussion of the abdomen a definite area of dullness may be noted in the lower part. Pelvic examination will show fluctuation in the cul-de-sac suggestive of fluid which is easily interpreted as being blood in view of the general appearance and condition of the patient. The blood count is of help in these cases as it shows a definite drop in hemoglobin and an increase in leucocytes.

GROUP 3: ILLUSTRATIVE CASES OF MASSIVE HEMORRHAGE

Miss T. G. (No. 22143), age 18 years, single, entered the hospital on September 18, 1935, complaining of an attack of sudden severe pain in the right lower quadrant of her abdomen which had increased in severity over the past few hours. She had a severe pain in her right shoulder and some upper abdominal discomfort. The patient had not vomited but was nauseated.

On examination the patient definitely appeared sick, pale, and worried; temperature, 37.3 degrees C., pulse, 98. There was noted some moderate distention and generalized, extreme tenderness in both lower quadrants of her abdomen which was dull to percussion and on auscultation no peristalsis was heard. Rectal-pelvic examination revealed tenderness in the cul-de-sac and the suggestion of a mass. Her last period was 3 weeks previous. During about 6 hours' observation the patient's pulse became more rapid and she showed more pronounced symptoms of shock.

Laboratory work: Hemoglobin, 50 per cent; red blood count, 3,650,000; white blood count, 12,500.

A tentative diagnosis of ruptured ovarian retention cyst with massive intraperitoneal hemorrhage was made. At operation over 1,000 cubic centimeters of blood was aspirated from the peritoneal cavity and retransfused into the patient. A cystic mass, the size of a small orange completely filled with clotted blood and representing a hemorrhage into a corpus luteum cyst of the right ovary, was removed. The patient made an uneventful recovery.

This case illustrates the severe type of hemorrhage that may occur as the result of a comparatively small tear or rupture in an ovarian retention cyst. Although a massive hemorrhage was found it was difficult to demonstrate either macroscopically or microscopically the exact point of rupture. The variability of the abdominal pains, its complete disappearance and reappearance at intervals, as well as frequent change in location, are characteristic.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

This condition occurs in women of the second and third decades of life. No single feature or symptom is characteristic but its variable manifestations strongly suggest the diagnosis. The variability of the abdominal pains, their complete disappearance and reappearance at intervals, as well as frequent changes in location, are characteristic. The initial pain may be severe although momentary and may be associated with trauma. Even without a history of trauma this pain may be of such severity as to awaken a patient from sound sleep. When the pain reappears later it is changed in character; it is dull, described as an abdominal discomfort; it is not colicky and seldom requires a narcotic. *The pain is sufficient to put both the doctor and the patient on guard but is insufficient to clearly define the type of pathology that is within the abdomen*, unless one has a "high index of suspicion." Many of the minor attacks of unexplained abdominal pains in female patients are probably on the basis of mild intraperitoneal bleeding. The abdominal tenderness present in these patients is as variable in its degree and location as the symptoms of pain. When found in the lower abdomen it is usually at a low level close to Poupart's ligament. Muscle guarding is present in proportion to the peritoneal irritation because of bleeding. Rigidity is seldom seen. Hyperactive peristalsis is an important accessory diagnostic finding.

Rupture of an ovarian retention cyst is most frequently diagnosed as acute appendicitis. This was the pre-operative diagnosis in 54 per cent of our series. Hoyt and Meigs report a similar diagnosis in 56 per cent of their cases. The onset of the pain in ruptured cysts is usually sudden and momentary, compared to the gradual and constant pain of appendicitis. The variability in duration and variation in location of the abdominal pain is unlike the steady and more definite location of appendicitis. On abdominal examination tenderness may be elicited only over the right lower quadrant and strongly suggests appendicitis. It later tends to shift to other parts of the lower abdomen more frequently than is seen in appendicitis. With increased bleeding abdominal tenderness becomes more generalized. *Even when the tenderness remains located in the right lower quadrant, careful examination will disclose that tenderness is just above the inguinal region in contrast to the periumbilical or McBurney tenderness of appendicitis.* The total white blood count and in particular the differential polymorphonuclear count are higher as a rule in acute appendicitis.

The next most frequent mistake in the diagnosis of this condition is its confusion with ruptured ectopic pregnancy. The occasional presence of continued vaginal spotting associated with retention cysts is probably due to an excess of estrin derived from the cyst and might lead to an erroneous diagnosis of ectopic pregnancy. The occurrence of massive hemorrhage with signs and symptoms of shock further confuses the picture. Differentiation in such cases depends on a careful

analysis of the menstrual cycle. In contrast to ectopic pregnancy there is usually no history of a missed or late period. The use of the urine pregnancy test is of considerable value in differentiation as it always is negative with ruptured cysts, and so frequently positive in ectopic pregnancy.

Occasionally this condition is confused with acute or subacute pelvic inflammation. This differentiation should be easily made because of the absence of high fever and the fact that these patients are not as sick as those with pelvic inflammation. Rigidity is not usually found in this condition. The sedimentation time is always normal in contrast to the rapid sedimentation time of pelvic inflammation.

Twisted ovarian cyst is usually a more sudden and severe emergency which on examination presents a well defined, tender, pelvic mass, the presence of which has usually been known to the patient for some time past.

Endometriosis, which clinically is a rather rare entity, may simulate this condition but the close relationship of its symptoms to the onset of menstruation should aid in the differentiation.

Treatment will depend largely upon the acuity of the clinician. If a correct differential diagnosis has been made and it is found that the patient is suffering from mild or moderate intraperitoneal bleeding, conservative observation is indicated. Such observation necessitates repeated examinations of the patient. With the proper diagnosis the greater majority of these cases will not need surgical intervention. It is our belief that many of the patients whom we operated upon in our series would spontaneously have stopped bleeding and re-absorbed the intraperitoneal blood. With greater experience and a more careful study of this subject we have found that we are operating less frequently. Pratt has reported a similar experience and recommends conservative observation.

Surgery should be performed if there are signs or symptoms of increasing or massive intraperitoneal hemorrhage, or when the diagnosis remains doubtful after a reasonable period of conservatism. A low midline incision is usually made and if a bleeding cyst is found it is resected and as much as possible of the good ovarian stroma is preserved. The ovary in such cases is usually resutured with fine silk. It is strongly urged that a McBurney incision should not be used in a female when there is any reasonable doubt of the diagnosis of acute appendicitis.

REMARKS

In the larger majority of our cases there does not appear to be a tendency to recurrence of this condition. However, there is a smaller group in which the condition seems to recur at frequent intervals. One of our patients had recurring attacks at every intermenstrual period for 6 consecutive months. These attacks were more definite than the so called "Mittel Schmerz" so frequently described in foreign literature but so infrequently seen in this country. She was given a course of endocrine therapy in the form of emmenin with a remarkable and complete disappearance of her attacks. Such a case suggests the probability that some of the new endocrine preparations may be of value in treatment when the condition is recurrent. In other cases in which the patients had been operated upon and appendectomy performed, as well as plastic resection of the affected ovary, the recurrent attack was treated conservatively because of the certainty of the diagnosis. To re-operate upon such a patient might mean the sacrifice of the involved ovary. Our policy has been to err on the side of conservatism and never remove the entire ovary in these young patients.

It is interesting to note that there were 4 patients who had recurring attacks. These were all nurses. Of the total series of 45, 11 of the patients or approximately 25 per cent were nurses. It is possible that their type of work which necessitates long hours in the upright position and often requires lifting of heavy patients, may predispose to ruptured cysts. Certainly the high incidence among nurses should be emphasized in relation to diagnosis.

The occurrence of proven appendicitis in 6 cases of this series in conjunction with a ruptured cyst is of interest. This finding has been noted in other reports (2, 6, 9, 10). One can theorize that the cyst rupture is a secondary and incidental accompaniment of the appendix attack and probably would not have occurred otherwise. There must be an increase in intra-abdominal pressure with the pain of acute appendicitis, particularly the obstructive type, which produces a rupture of a pre-existing cyst.

CONCLUSIONS

1. For clinical purposes the term, ovarian retention cyst, is advocated in the discussions of rupture of graafian follicle and corpus luteum cysts.

2. Intraperitoneal hemorrhage from rupture of an ovarian retention cyst has not received sufficient recognition in the differential diagnosis of acute surgical abdominal conditions.

3. A classification into 3 groups of *mild*, *moderate*, and *massive* hemorrhage resulting from rupture of ovarian retention cyst is described. The

clinical aspects of this entity are determined by the amount of intraperitoneal bleeding.

4. The mechanism of rupture may be due to increased intracystic pressure from spontaneous bleeding into the cyst, or increased extracystic pressure from trauma of various types.

5. The diagnosis of the condition is dependent upon time relation to the previous menstruation, characteristic variation in abdominal pain and tenderness, the presence of active peristalsis, and frequently positive pelvic findings. A "high index of suspicion" aids materially in the diagnosis.

6. Rupture of an ovarian retention cyst must be differentiated from: (1) acute appendicitis; (2) ectopic pregnancy; (3) pelvic inflammatory disease; and (4) torsion of an ovarian cyst.

7. The majority of these cases can be treated by conservative observation after the proper diagnosis is made. The tendency to recurrent attacks is rare but does occur, and the possibility of treatment by endocrine therapy is suggested in such cases.

8. Rupture of ovarian retention cysts seems to have a high incidence among nurses.

9. When surgical intervention is necessary, the entire ovary should not be sacrificed. Plastic resection of the cyst and preservation of normal ovarian tissue is advocated.

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THE CONSERVATIVE SURGICAL TREATMENT OF NON-CALCULOUS HYDRONEPHROSIS

JAMES T. PRIESTLEY, M.D., F.A.C.S., Rochester, Minnesota

INTERFERENCE with the flow of urine from a kidney, which persists for any appreciable length of time, invariably causes some degree of hydronephrosis. The extent of pyelectasis and caliectasis which results varies and depends upon the degree and duration of obstruction, the presence of infection, the status of renal function, and other related factors. The conservative surgical procedure which is indicated to relieve symptoms and prevent further damage to the renal parenchyma must be altered according to the exact anatomical relationships that are present.

Many advances have been made during the past 20 years in the conservative surgical treatment of hydronephrosis, so that now many kidneys are preserved which previously would have been considered irreparably damaged and removed. As experience with this type of surgery has grown, the results, both immediate and ultimate, have become increasingly more satisfactory (10). The present discussion will be limited entirely to the conservative surgical management of hydronephrosis. Symptoms, diagnosis, indications for operation, significance of infection, and other aspects of the subject, will not be discussed. No attempt will be made to discuss the historical development of the conservative surgical treatment of hydronephrosis nor to review the current literature on the subject.

CAUSES AND SURGICAL PROCEDURES

Anomalous vessels. Anomalous blood vessels directed to the lower pole of the kidney constitute one of the abnormalities first described as a cause for hydronephrosis (1, 6). For many years the etiological relationship of these vessels to hydronephrosis remained unquestioned. In recent years, however, certain authors have expressed the belief that aberrant vessels of this type are only of secondary importance and are not primarily responsible for the hydronephrosis (11). At present there is, therefore, some divergence of opinion regarding the importance of these vessels in the production of hydronephrosis. It is certainly true that the mere presence of anomalous vessels to the lower pole of the kidney is of no definite significance unless it can be clearly demonstrated that they interfere with drainage from the kidney.

Rather than formulate a dogmatic opinion regarding all anomalous vessels, it appears more reasonable to judge each case individually. At the time of operation, when actual anatomical relationships can be accurately ascertained, marked variations are noted in different cases. The responsibility for determining the exact factors concerned in the production of the hydronephrosis, therefore, resides with the surgeon. In some cases there seems to be no possibility that aberrant vessels to the lower pole interfere with drainage from the renal pelvis. In these cases the anomalous vessels are not even in contact with the ureter or pelvis. In other cases it seems equally apparent that these vessels are a definite factor in the production of hydronephrosis, although it is realized that their apparent importance may be accentuated as the pelvis gradually increases in size. One may find the ureter sharply angulated or flattened against the pelvis by pressure of the vessels. Active peristalsis may be seen in the pelvis and upper portion of the ureter, but despite this fact the pelvis remains distended. After the vessels are severed and pressure on the ureter is released, the pelvis empties readily.

If anomalous vessels are present and one demonstrates to his satisfaction that they are of importance in the production of hydronephrosis, one of several surgical procedures may be necessary. The vessels may first be temporarily occluded to determine their importance in the blood supply of the lower pole of the kidney. If no undue change in color takes place during compression for several minutes, the vessels may be severed with impunity. Should the lower pole become very dark and should a sharp line of demarcation appear between the main portion of the kidney and the lower pole, the vessels cannot be divided without producing an infarct in the portion of the kidney which they supply. Under these circumstances, if the vessels are definitely compressing or angulating the ureter, it may be necessary to sever the ureteropelvic juncture and re-implant the ureter into the pelvis on the opposite side of the vessels (4). At times such a pro-

From the Division of Surgery, The Mayo Clinic.

cedure may be indicated when the ureter has been inserted high up on the pelvis and has been compressed against the pelvis by aberrant vessels. At the time of re-implantation the ureter is then placed dependently in the renal pelvis (Fig. 1).

If the pyelectasis found to be associated with anomalous vessels is very extensive and if the pelvic wall is thin and flabby and apparently contains little if any musculature capable of effective peristalsis, resection of the pelvis may be performed (Fig. 2). This procedure has been employed frequently by Walters (9). It is realized that the main object of any operation for hydronephrosis is to improve drainage from the kidney and not primarily to decrease the size of the extrarenal pelvis. If a very large redundant pelvis is present, however, it seems quite possible that urine might stagnate there because of the excessive size of the pelvis and its inability to empty. It has been stated that resection of the pelvis interferes with normal peristalsis (5); however, experience with this type of operation has demonstrated that emptying of the pelvis under certain circumstances may be improved by this procedure. If the pelvis is not too large and if it appears to have active peristalsis, it will usually empty itself satisfactorily after the obstruction has been removed, and resection of the pelvis is not necessary.

High insertion of ureter into renal pelvis. One of the common abnormalities found associated with hydronephrosis is high insertion of the ureter into the renal pelvis. Obviously, when this anatomical abnormality exists, dependent drainage of the pelvis is lacking. It may be stated that such a relationship between the pelvis and ureter is merely the result and not the cause of the hydronephrosis and it is difficult actually to prove or disprove this contention. It is true, however, that pyelectasis and varying degrees of caliectasis are not infrequently found to exist when there is no explanation for their occurrence other than the fact that the ureter leaves the pelvis in its middle or upper portion. Undoubtedly, this abnormality can sometimes be rendered more important in its appearance as the size of the pelvis increases. It seems very probable, however, that in certain cases this faulty anatomical relationship is primarily responsible for the production of the hydronephrosis. Frequently, as stasis occurs and as the pelvis gradually enlarges, the upper portion of the ureter is compressed by lateral pressure from the distended pelvis. This results in further interference with drainage. Occasionally fibrous bands hold the ureter closely pressed against the pelvis. Under such circumstances one is usually surprised that urine leaves the kidney as well as it does. The ureteropelvic juncture may be on the posterior or anterior surface of the pelvis, but it is usually located on the medial aspect of the pelvic wall.

The correction of high insertion of the ureter may be accomplished by a variety of surgical procedures, 3 of which are illustrated in Figures 3, 4 and 5. In general, an operation which does not entirely sever the ureter from the pelvis is to be preferred, when feasible, as the blood supply and nerve supply to the upper portion of the ureter are not disturbed by this type of operation. One of the simplest and most satisfactory procedures consists of simple anastomosis between the ureter and pelvis, so called ureteropyeloneostomy (Fig. 3). In this operation a new opening is made between the most dependent portion of the pelvis and the ureter at the corresponding level.

A second procedure that may be employed, which is quite similar in principle to the one just described, is illustrated in Figure 4 (5). The adjacent portions of the ureter and pelvis are incised in a straight line and the cut edges are then united, posterior edge of pelvis to posterior edge of the ureter and anterior edge to anterior edge, which is similar in principle to the Finney pyloroplasty.

Another procedure which I have not seen described in the literature but which I have employed with satisfactory results in cases of high insertion of the ureter is illustrated in Figure 5. In this operation a longitudinal incision is made in the upper portion of the ureter which lies adjacent to the pelvis. This incision is carried down to a level which corresponds with the most dependent portion of the pelvis, which is near (approximately 1 centimeter) the renal parenchyma of the lower pole. The dependent portion of the pelvis which lies between the lower pole of the kidney and the ureter is then resected in a wedge shaped manner, with the base of the wedge directed downward and the apex reaching upward to the level of, or a little above, the ureteropelvic juncture. The anastomosis between the remaining portion of the pelvis and the longitudinal incision in the ureter is then completed in the usual manner. This procedure has the advantage of bringing the ureteropelvic juncture close to the kidney in a dependent position, creating a funnel shaped pelvis, and furthermore removes the excess portion of the pelvis that usually remains when an ordinary anastomosis is performed without removal of tissue. The operation described by Foley may also be used in cases of this type, although it was described for use in

cases of stricture at the ureteropelvic juncture.

Somewhat less conservative operations may at times appear advisable. Occasionally it may seem necessary to sever the ureteropelvic juncture completely, resect the upper portion of the ureter which lies adjacent to the pelvis, and re-implant the upper end of the ureter in the lowest portion of the pelvis. This may or may not be combined with resection of the pelvis. If the pelvis is resected, the line of incision may be carried to within 1 centimeter of the renal parenchyma, both on the anterior and posterior walls. The ureter is then inserted at the lower angle of the pelvis. This procedure, as utilized for stricture of the ureteropelvic juncture, is illustrated in Figure 6. This type of operation is best reserved for cases of large hydronephrosis in which there is a very thin, markedly dilated pelvis which has flattened and narrowed the upper portion of the ureter. Accurate anastomosis between ureter and pelvis is desirable. The upper end of the ureter may be incised downward for a short distance in order to increase the diameter of the resulting ureteropelvic juncture if it appears advisable.

Narrowing at ureteropelvic juncture. Hydronephrosis may be caused by narrowing of the lumen of the ureteropelvic juncture as a result of scar tissue, trauma of one form or another, inflammatory reaction, fibrous bands, idiopathic stricture, or other causes. Many types of surgical procedures have been employed for the correction of this condition, with variable results. Employment of the principle of the Heineke-Mikulicz operation for pyloroplasty, known as the "Fenger operation," is one of the simplest procedures technically; however, ultimate results following this type of procedure, which utilizes a longitudinal incision through the strictured region closed transversely have not been so satisfactory.

Schwyzer modified Fenger's operation by using a Y-shaped incision, the diverging limbs of the Y being placed on the pelvis above the ureter and the descending limb being extended down the ureter. This incision is closed so that the dependent point of the triangular flap created on the pelvis is approximated to the lower end of the incision in the ureter. The diameter of the ureteropelvic juncture is thereby increased, with some redundancy in the upper end of the ureter opposite the anastomosis. Foley modified this operation by placing the diverging limbs of the Y incision downward on the lower portion of the pelvis directly opposite the upper end of the ureter. The straight incision in the ureter is made somewhat longer than in the Schwyzer operation and on the side of the ureter adjacent to the pelvis. The dependent tip of the flap on the pelvis is approximated to the lower end of the incision in the ureter and the anastomosis is completed accordingly. This provides a large ureteropelvic juncture with a funnel shaped opening into the pelvis. Satisfactory results have been reported following this procedure.

If the pelvis is unusually large and the upper portion of the ureter somewhat redundant, resection of the renal pelvis and upper portion of the ureter and re-implantation of the ureter usually gives very satisfactory results (Fig. 6). This procedure is especially advantageous when a more conservative operation without resection would leave an excessively large renal pelvis and give doubtful results. In this type of operation it is especially important to leave the ureteral "splint" catheter in place for an adequate length of time.

Square shaped pelvis with medial insertion of ureter. Occasionally one finds hydronephrosis with a square shaped extrarenal pelvis and a ureteropelvic juncture (of adequate lumen) situated dependently on the medial aspect of the pelvis. The ureter is then a considerable distance from the lower pole of the kidney. It is difficult to determine just how an anatomical arrangement of this type might be responsible for the development of the hydronephrosis. It may often appear as though the relationship were merely secondary, the hydronephrosis having developed from some undetermined cause. Whichever the case may be, the late results obtained following operation make it appear worth while in some of these cases to resect a wedge shaped portion of the lower part of the pelvis situated between the ureter and lower pole of the kidney. The base of the wedge is excised from the lowermost portion of the pelvis and the apex is directed upward. Such a procedure brings the ureter and ureteropelvic juncture close to the lower pole of the kidney and makes the dependent portion of the pelvis more funnel shaped and less flat. Such an arrangement sometimes appears to enhance drainage.

Hydronephrosis associated with movable kidney. That most cases of slightly abnormal renal ptosis or mobility are of clinical significance seems highly improbable, and I believe that such a viewpoint will avoid many unnecessary operations. That certain cases of abnormal renal ptosis associated with some degree of hydronephrosis and pain which appears to be of renal origin are of clinical significance seems almost equally certain. I do not think there are many such cases, but one is occasionally encountered. If the clinical diagnosis has been established with as much

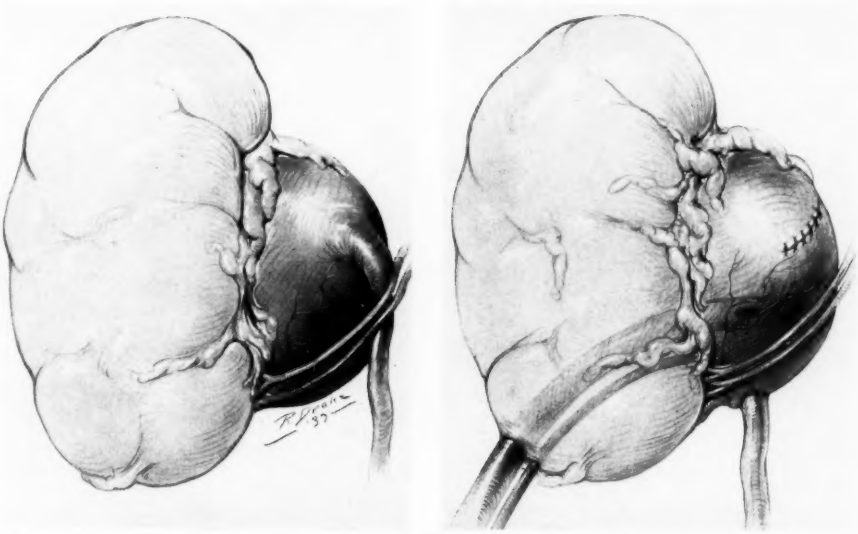

Fig. 1. Hydronephrosis associated with aberrant vessels and high insertion of ureter; a, left, high insertion of ureter into the enlarged pelvis, upper portion of ureter compressed by aberrant vessels running to lower pole of kidney, and b, resection of upper portion of ureter and re-implantation into dependent portion of pelvis. The aberrant vessels could not be severed without causing an infarct in lower pole of kidney.

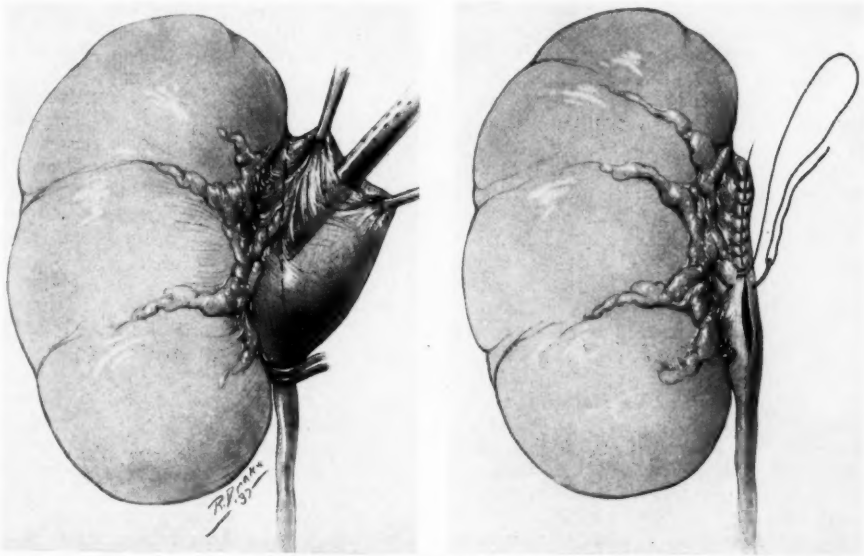

Fig. 2. Hydronephrosis associated with aberrant vessels; a, left, compression of ureteropelvic juncture by aberrant vessels, and b, aberrant vessels severed and enlarged extrarenal pelvis resected.

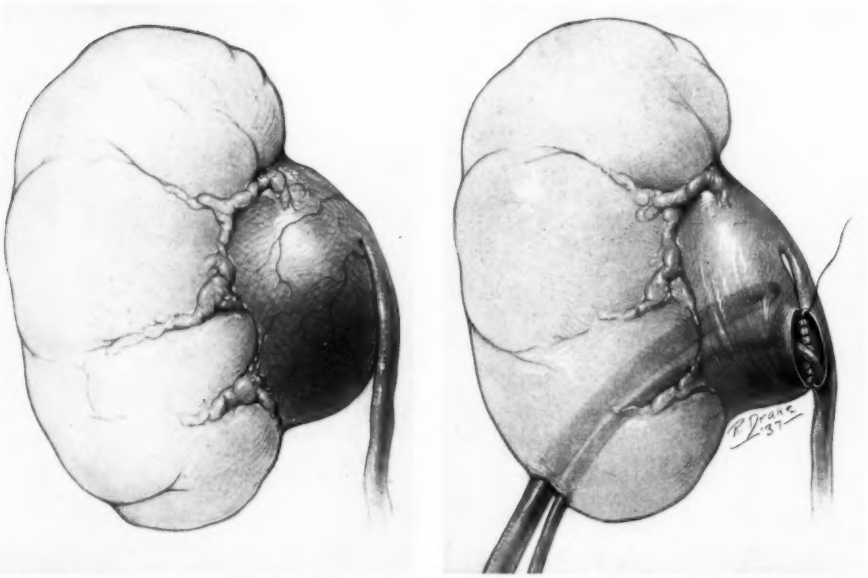

Fig. 3. Hydronephrosis associated with high insertion of ureter; a, left, high insertion of ureter into enlarged pelvis; b, anastomosis between dependent portion of pelvis and adjacent portion of ureter.

certainty as possible and if definite stasis has been actually demonstrated, a pleasing result may follow immobilization of the kidney in an appropriate position so that undue angulation or kinking of the ureter or ureteropelvic juncture does not occur. If such a condition is found in the right kidney of a patient who has a low-lying liver, as is often the case, one need not attempt to maintain the kidney in an anatomically high position where, with each inspiration, the liver will push down on the upper pole. All that is actually necessary is to fix the kidney in a relatively high position so that it does not descend unduly when the patient is standing. The details of performing nephropexy will not be discussed except to say that elaborate methods of fixation are unnecessary. One does not need to operate on many kidneys which have been subjected to a previous operation before realizing that nature does a very good job of fixing the kidney following almost any type of renal operation.

Hydronephrosis resulting from other causes. Hydronephrosis which results from various abnormalities in the lower portion of the urinary tract, and from pathological conditions entirely extrinsic to the urinary tract, is not at all uncommon. Tumor of the ureter, ureteral stricture, vesical neoplasm, obstruction in the neck of the bladder, and so forth, and numerous pelvic conditions such as tumors, inflammatory processes, and trauma in one form or another, may result in obstruction of one or both ureters. Likewise, abdominal or retroperitoneal tumors, which cause pressure on the ureter or renal pelvis, may result in varying degrees of pyelectasis and caliectasis. The treatment of hydronephrosis resulting from these causes will not be discussed since the primary concern under these circumstances is the original lesion responsible for the secondary effects on the kidney. In cases of this type local conservative operation on the kidney is seldom indicated.

Hydronephrosis of indeterminate origin. Occasionally one encounters definite hydronephrosis without an adequate anatomical explanation for its development. Sometimes the hydronephrosis may be unilateral, at other times bilateral. In children, bilateral hydronephrosis without evidence of organic obstruction is not uncommonly seen. It seems possible that disturbances of function may eventually cause an anatomical abnormality for which there is no recognizable organic lesion. Although the exact cause for such hydronephroses, to my belief, has never been conclusively demonstrated, the current tendency is to explain them on the basis of neuro or neuro-

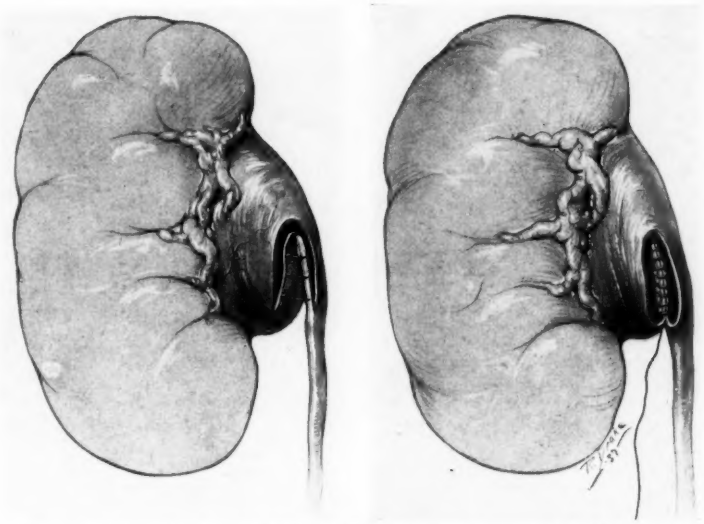

Fig. 4. Hydronephrosis associated with high insertion of ureter; a, left, high insertion of ureter into dilated pelvis; b, anastomosis between dependent portion of pelvis and adjacent portion of ureter.

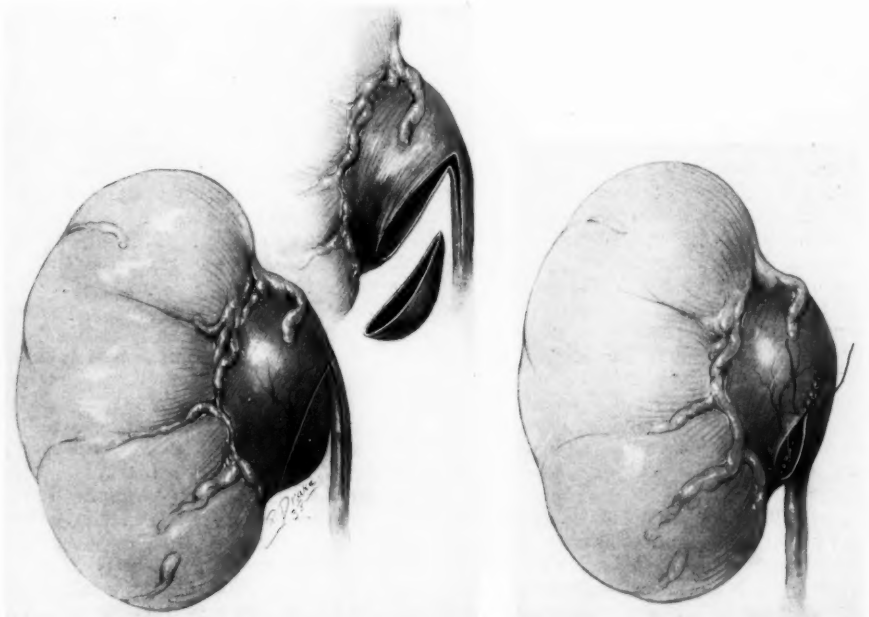

Fig. 5. Hydronephrosis associated with high insertion of ureter; a, left, high insertion of ureter into enlarged pelvis; b, wedge shaped resection of lower portion of pelvis and ureteropelvic anastomosis.

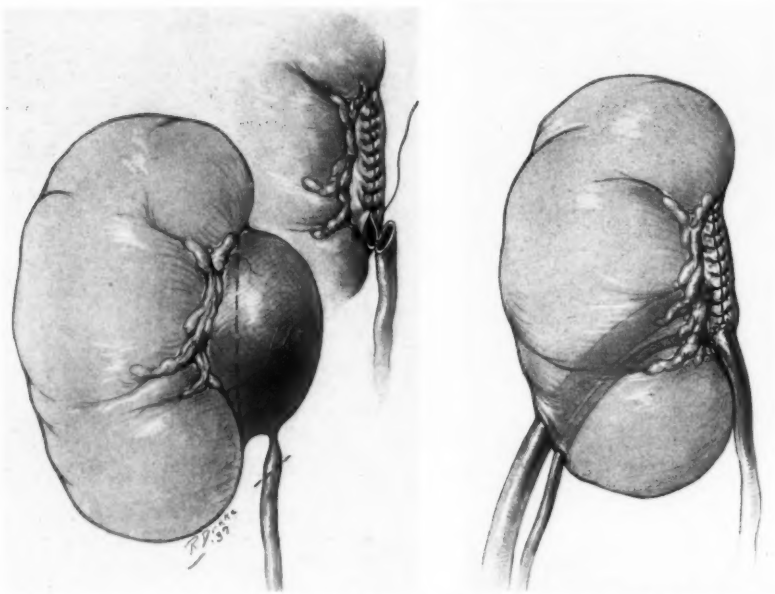

Fig. 6. Hydronephrosis associated with stricture at ureteropelvic juncture; a, left, stricture at ureteropelvic juncture, with resultant hydronephrosis, and b, resection of extrarenal pelvis and strictured region of ureter with re-implantation of upper end of ureter into dependent portion of pelvis.

muscular dysfunction. Obviously when no actual obstruction is present, little benefit may be expected from any type of plastic operation. The ultimate results of various types of operative procedures carried out on the autonomic nervous system in a large series of cases, remain to be seen. Individual cases and small groups of cases have been reported with reputed benefit following denervation of the renal pedicle, ureterolysis, section of the ureteropelvic sphincter, and resection of the presacral nerves. Experience has been limited with all of these procedures and they will not be discussed in detail at this time. Suffice it to say that further experience, both experimental and clinical, is desirable before definite conclusions can be drawn.

Hydronephrosis in kidney with duplicated pelvis. Duplication of the pelvis of one or both kidneys is one of the most frequent congenital abnormalities that occurs in the urinary tract. Often such a condition causes no symptoms as both segments of the kidney function normally and there is no superimposed disease or abnormality. At times, however, hydronephrosis or other changes may develop, usually in one but occasionally in both segments of the kidney. When hydronephrosis develops in one segment only and the other half of the kidney is functioning normally, a conservative operation rather than nephrectomy is desirable.

If hydronephrosis occurs in one segment of a kidney with double pelves it is usually in the upper half, and it may be caused by a variety of factors, such as ectopic lower opening of the ureter or other anatomical abnormality, a kink or sharp angulation in the ureter, narrowing of the ureter by pressure, and so forth. For the conservative surgical correction of such a condition a number of different procedures have been utilized, with varying degrees of success. Heminephrectomy is the operation which has given the most uniformly satisfactory results at The Mayo Clinic (Fig. 7). In this operation the diseased portion of the kidney and at least a portion of the attached ureter are removed. This procedure is usually not difficult and in a majority of cases can be performed with a low risk and a good result. Complete ureterectomy is not necessary even if marked ureterectasis is present unless there is definite obstruction in the lower portion of the ureter. Ligation of individual blood vessels to the involved portion of the kidney and temporary com-

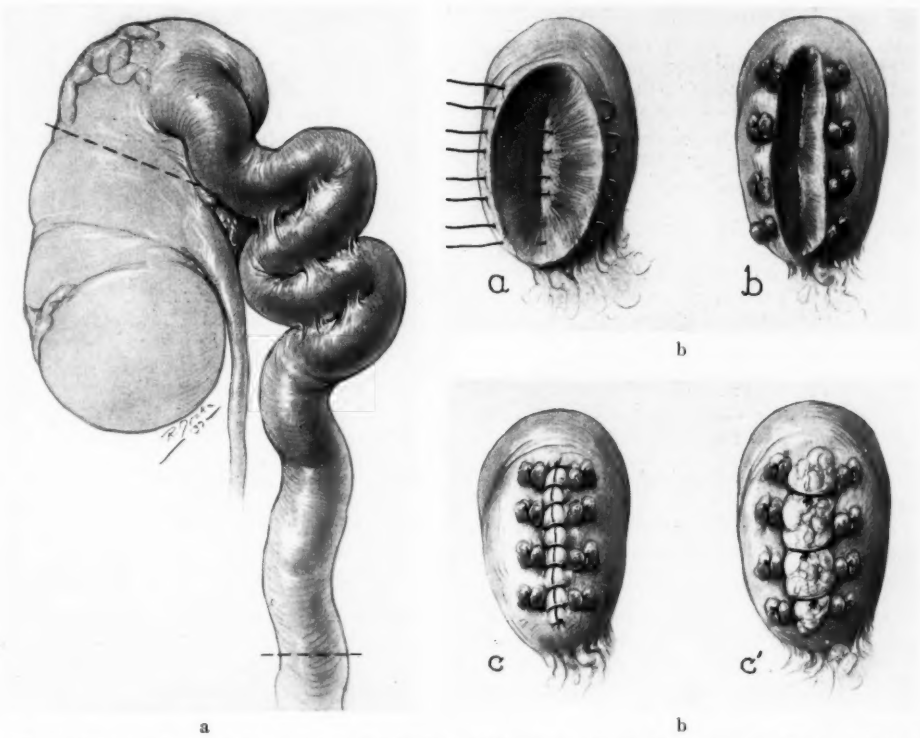

Fig. 7. Hydronephrosis in upper segment of duplicated kidney; a, redundant hydro-ureter; the lower half of kidney is normal, and b, heminephrectomy, removing upper half of duplicated kidney.

pression of the renal pedicle with a rubber covered clamp facilitate the procedure. The line of resection should be placed so that neither a calyx nor a pelvis is opened. By making a wedge shaped excision of the involved segment, the edges of the defect in the remaining portion of the kidney can be approximated. Large individual vessels seen on the cut surface of the kidney may be ligated with interrupted mattress sutures. Following this the edges of the kidney may be approximated with similar sutures tied over muscle tissue and finally covered with a pad of fat held in place by a continuous running suture through the renal capsule.

Other operations which are described for hydronephrosis in half of a duplicated kidney include: mere ligation of the ureter from the involved segment, various types of anastomoses of the ureters and pelves of the 2 segments, and re-implantation of the involved ureter into the bladder in case it has an ectopic opening. The enlarged renal pelvis may be anastomosed to the one of normal size. The ureter of the involved segment may be joined to the normal pelvis or ureter. As a general rule, results following these operations are less satisfactory than following heminephrectomy. Occasionally, if it is essential to preserve all possible functioning renal parenchyma, some type of anastomosis or a re-implantation may be advisable.

Hydronephrosis in a unilateral fused kidney. Occasionally a unilateral fused kidney presents definite hydronephrosis in one segment with resultant symptoms. Generally this may be treated in the same manner as hydronephrosis in one segment of a duplicated kidney. The exact procedure that is necessary will change with the individual patient, depending on the anatomical and functional relationships encountered.

Hydronephrosis in an ectopic kidney. Hydronephrosis sometimes develops in an ectopic kidney. This may be caused by pressure on the

ureter from an abnormal blood supply (which is the rule rather than the exception under such circumstances) or by some other cause of ureteral obstruction such as acute angulation, redundancy with kinking, or external pressure on the ureter. In the surgical treatment of kidneys of this type which are producing symptoms, nephrectomy gives the most uniformly satisfactory results provided the other kidney is in good condition. Because of the abnormal position of the kidney and its unusual blood supply, conservative plastic operations are less often successful than in cases in which the kidney is normally placed. They may at times be necessary, however, because of bilateral renal disease. The exact type of procedure that is indicated will vary from case to case and depends on the cause of obstruction, and for this reason no universally applicable procedures can be described. In general, if a conservative operation is performed, the same surgical principles should be utilized as in dealing with a kidney in a normal position.

Hydronephrosis in a horseshoe kidney. The horseshoe kidney which shows evidence of hydronephrosis usually presents a very clear cut problem at the time it is exposed surgically. It has been our preference at the clinic to utilize the ordinary posterolumbar incision in these cases, continued somewhat more anteriorly than usual, with the patient placed at an angle of 45 degrees with the table. This type of incision and position provide adequate exposure. Obstruction to the free drainage of urine from the pelvis is usually caused by high insertion of the ureter, or pressure on the ureter from aberrant blood vessels, the lower pole of the kidney or the renal isthmus. Occasionally, angulation of the ureter by fibrous bands may be present.

Depending upon the etiological factors responsible for the hydronephrosis, the surgical indications will vary. Ordinarily plastic operations on the ureter and pelvis can be as easily performed on a horseshoe kidney as on a single kidney. The pelvis is commonly found to lie anteriorly, which compensates for the fact that renal mobility is somewhat limited because of direct attachment to the opposite kidney. In case the hydronephrosis is caused by high insertion of the ureter into the pelvis, ureteroneopyelostomy (Figs. 3 and 4) usually gives a good result. In case the renal isthmus causes pressure on the ureter, which I believe is uncommon, it is necessary to divide the isthmus so that the ureter is not compressed as it passes downward. When this is done it is often essential to fix the lower pole of the kidney laterally to the lumbar muscles in order to avoid pressure by the lower pole on the ureter. In the limited group of cases of hydronephrosis in horseshoe kidneys in which conservative operations have been performed, the ultimate results have been equally as satisfactory as following operations on single, normally placed kidneys.

GENERAL CONSIDERATIONS

Certain general surgical considerations that seem important in obtaining satisfactory results following plastic operations on the kidney might be mentioned. Absorbable suture material is universally employed, because non-absorbable sutures may readily form the nidus for crystalline deposit, especially when infection is present. Personally, I prefer a single row of interrupted catgut sutures for closing the pelvis. There may be some slight leakage of urine during the early postoperative period with this type of closure, but this does no real harm and affords an additional safety valve in case of increased intrapelvic pressure. Additional rows of suture are unnecessary and only increase the amount of local reaction and tissue that subsequently will slough.

Drainage by nephrostomy is widely recognized as a valuable adjunct to practically every plastic operation performed on the ureteropelvic juncture. With such provision for immediate drainage during the early postoperative period the incidence of secondary nephrectomy and functional failure of operation is definitely reduced.

When any procedure has been carried out at the ureteropelvic juncture, the use of an indwelling catheter which traverses the lower pole of the kidney, lower calyx, pelvis, ureteropelvic juncture, and ureter in order, so called "ureteronephrostomy," is of definite value. A small, soft rubber catheter, size 10 to 14 French, is preferred to the commonly employed harder, smaller ureteral catheter. An extra hole is cut in the portion of the catheter that remains in the pelvis so that there may be free drainage of urine through the catheter either outward to the collecting bottle or downward to the bladder. The catheter should be passed down the ureter a sufficient distance so that it will not be easily dislodged. This catheter serves to maintain an adequate lumen of the ureter at the site of operation and in addition discourages undesirable angulation of the ureter which might otherwise occur during the early postoperative period. The length of time that the catheter and nephrostomy tube are left in place varies with the individual case. If an extensive plastic operation has been performed, such as complete resection of the renal pelvis and re-implantation of the ureter, it may

be advisable to leave the tube in place for as long as 3 months. If a less extensive type of procedure has been carried out, 3 weeks may be ample. In general it is wiser to err on the side of leaving the tubes in place for too long rather than too short a time. As healing occurs and as the resultant scar tissue contracts, the lumen of the ureteropelvic juncture may be narrowed unless the catheter remains in place.

It is generally advisable to fix the kidney in a position which is most favorable to good drainage at the conclusion of a plastic operation. This does not mean that the kidney must always be fixed in exactly the same position nor in the same manner. The most desirable position must be ascertained in each individual case and the kidney then immobilized in this position. The wound should always be drained.

COMMENT

As one can readily surmise from a brief review of the many different surgical procedures that have been suggested and tried in the conservative treatment of hydronephrosis, the surgical management of this condition is far from standardized. Although it is more than 50 years since the first plastic operation on the kidney was reported (8), relatively few operations of this type were performed until 20 years ago. Since then this field of surgery has expanded greatly and, at present, many plastic operations are performed on the kidney each year. Some of the earlier procedures have been discarded and certain newer ones have been developed. As more time elapses, evaluation of ultimate results will become more accurate. At some time in the future the technical aspects of conservative renal surgery will undoubtedly become more standardized, and perhaps certain of the procedures which are utilized today will be altered or discarded.

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EDITORIALS

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"DECOMPRESSION" OF THE INTESTINAL TRACT

ACCORDING to Paine, the first stomach tube was probably made and used by John Hunter in the latter part of the eighteenth century. Shortly thereafter, improvements in the types of tubes were reported in the United States, France, and England. Kussmaul rediscovered the stomach tube in 1865 and it is due in no small part to him that it was popularized as a diagnostic and therapeutic instrument. Ewald and Oser in 1874 described stomach tubes made of softer rubber and with a smaller lumen and showed that they could be introduced without using stylets.

Most of the pioneer work on the development of the duodenal tube was performed in America. Turck and Hemmeter described tubes with which the duodenum had been intubated. Shortly thereafter, Einhorn and Gross independently simplified and improved them. Gross recommended that the patient should lie on the right side after the tube had been swallowed in order to facilitate passage into the duodenum. Levin in 1921 described the smooth catheter tipped duodenal tube which could be passed through the nares. Many other types have been described, but extensions in the indications for usage have greatly outstripped the improvements in construction.

Whereas the duodenal tube was employed almost exclusively as a diagnostic procedure for many years, it is being used more and more in recent times as a therapeutic agent and particularly in the treatment of intestinal distention. Approximately 25 years ago, its use for continuous siphonage drainage was advocated by Westermann and Karpis in the treatment of distention associated with peritonitis. Kanavel and Matas made contributions to this subject. The work of McIver and his associates in which they showed the important rôle played by swallowed air in the genesis of postoperative distention has extended the indications for "decompression" therapy. Many surgeons have treated postoperative distention and other conditions by the use of the duodenal tube as a siphon. Ward of San Francisco was the first to employ continuous suction to the duodenal tube in the treatment of peritonitis. Wangensteen was the first to use the principle of continuous suction applied to the duodenal tube in the treatment of some types of mechanical obstruction of the small intestinal tract. The popularization and perfection of this therapeutic procedure is due largely to Wangensteen and Paine. Whereas siphonage is efficient in the drainage of the urinary bladder and other closed cavities of the body, they showed that the difference in the effectiveness of siphonage drainage of the gastro-intestinal tract as contrasted with the

other cavities is dependent on the presence of gas as well as fluid which enters the tube and stops its action. Siphonage is dependent on the difference in the heights of two columns of water and the presence of a moderate quantity of gas destroys its effectiveness. Continuous mild suction is a better means of removing the combination of gas and fluid. Wangensteen and Paine have shown that, when the obstruction is due to adhesions and is accentuated by the accompanying distention, it may be relieved permanently by suction applied to a duodenal tube. Further, they showed that deflation of the stomach and upper part of the small intestines renders the operation, if such is necessary, less dangerous and easier to perform. In this connection, it may not be amiss to state in a short-circuiting operation in which collapsed and distended loops of intestine are anastomosed that one should be certain that the collapsed intestine is not that which has been decompressed by the tube and hence is proximal to the point of obstruction.

However, there are a good many patients in whom gastroduodenal suction is not successful in relieving the distention. Furthermore, even though the distention is relieved by the duodenal suction, the location and nature of the lesion may still be unknown. It is in these cases that the intestinal intubation method of Miller and Abbott may achieve gratifying results. In principle, the method consists of passing through the nose into the small intestinal tract a double lumen tube or a pair of tubes, the larger opening being used for aspiration purposes and the smaller one for the inflation of a rubber balloon which surrounds its distal end. With the combination of aspiration of the intestinal contents and of inflation of the balloon, peristalsis carries the tube down the intestinal tract. This takes place whether the obstruction is mechanical or paralytic. It offers an interesting and new method for many physiopathological studies on man and animals. Striking results following its use in patients with distention due to several causes have been reported by Abbott and Johnston, Penberthy, Noer and Kenning, and by others. In a number of instances, decompression has released the obstruction and operation has been unnecessary. The tube usually advances until the tip reaches the point of obstruction. Under these conditions, examination of the aspirated material and the injection of an opaque suspension combined with x-ray studies may reveal the location and the nature of the lesion.

The men who have developed the methods for decompression of the intestinal tract are quite conservative in their claims. It is emphasized that this therapy should not be used in cases of strangulation of any part of the intestinal tract and in instances of obstruction of the large bowel. Since strangulated external hernias usually present no difficulty in diagnosis, costly mistakes are most apt to occur in instances of volvulus, internal hernia, and intussusception. Since early operation is urgently indicated in patients with strangulation, the time required for the passage of the tube is not permissible. The greatest difficulty usually lies in getting the tube to pass through the pylorus into the duodenum but it is likely that better methods for doing this will be evolved. In general it may be stated that a trial with suction is permissible in those cases in which clear indications for immediate operation do not exist. It cannot be emphasized too strongly that the person who elects to treat a patient with mechanical obstruction by non-operative means must use the x-ray in following the results of the therapy. If suction does not result in decompression in 24 to 36 hours, an operation is indicated. Prolonged non-operative management is apt to be especially dangerous in the absence of a

history of previous abdominal operations since under these conditions adhesions are not so likely to be the cause of the obstruction.

If the contra-indications to the use of intestinal intubation are understood fully and, if the patients are chosen properly, the method may offer many advantages. It may make an operation unnecessary by relieving the distention above the point of obstruction with a resulting re-establishment of the normal intestinal continuity. Even if an operation is necessary, it may be used in preparing the patient by relieving the distention, making for an easier procedure both for the patient and the surgeon. It offers a non-operative means of combating the distention in paralytic ileus. Conditions other than mechanical obstructions in which the employment of suction may be indicated include the physiological obstructions whether they accompany operations, infection, or a variety of conditions including the distention accompanying uremia, pneumonia, and fractures. The work of Fine, Sears, and Banks indicates that the inhalation of oxygen may be effective in combating the distention associated with some of these conditions. Intestinal intubation offers a means of supplying fluids when they are needed urgently. It affords a possible method for determining the location and nature of the lesion in the intestinal tract. It may be used to diminish the tension on sutures in the intestinal tract or to permit a greater delay in the making of an opening in an exteriorized portion of the intestines. Following eviscerations through incisions, it may be employed in combating distention. Duodenal suction alone will be effective in many of these conditions but the use of the double tube with the balloon increases the area which is accessible.

The therapeutic procedures enumerated are relatively new and undoubtedly many improvements in the methods now used will be made. Since they offer such bright possibilities, it is hoped that indiscriminate and ill advised usage will not retard their development. It seems quite likely that the decreasing popularity of enterostomy in the treatment of ileus, paralytic and otherwise, will decrease still further as a result of the effectiveness of these non-operative means of therapy.

ALFRED BLALOCK.

HYDATIDIFORM MOLE AND CHORIO-EPITHELIOMA

A STUDY of the extensive papers on hydatidiform mole and chorio-epithelioma written prior to 1930 (the year in which the Aschheim-Zondek test became of practical use) reveals that the mortality rate for mole was approximately 12 per cent and that of chorio-epithelioma 60 per cent. During that period hydatidiform mole was usually not diagnosed until hydatid vesicles were demonstrated, and the presence of chorio-epithelioma was not suspected until metastases had appeared. A recent five year survey of these two diseases on the Pacific coast and a review of the world's literature for 1935, 1936, and 1937 shows that the mortality rate for hydatidiform mole and for chorio-epithelioma has dropped to 2 per cent and 10 per cent, respectively. Analysis of the recent literature points to the fact that the decreased mortality is the result of early diagnosis by means of the various biological pregnancy tests which have come into vogue and early treatment by hysterectomy.

At the present time there is sufficient evidence in the literature to show that it is safe to leave the ovaries when hysterectomy is performed. The exceptions to this rule would be, of course, primary chorio-epithelioma of the ovary following ovarian pregnancy, pri-

mary chorio-epithelioma of the ovary due to a chorio-epitheliomatous growth in a teratoma, or actual metastases which seriously involve the ovary. Torsion of an ovary containing lutein cysts or enormous enlargement of an ovary as a result of lutein cysts would probably necessitate removal of the involved ovary.

In order that even better results may be obtained, loose concepts must be abolished, more exact knowledge and better interpretation of the tests for gonadotropic hormone must be had, and a technique better than is at present extant is needed so that the most minute amounts of living chorionic tissue can be detected. And it is to be hoped that pathologists by more extensive and more painstaking examination of the mole will ultimately be able to formulate criteria that will establish potential malignancy and thus enable us to prophesy the advent or to determine the existence of chorio-epithelioma. The highest percentage of cures will be obtained when there is judicious correlation of the clinical history, verification of the histological examination, and intelligent interpretation of the biological pregnancy tests. It would appear if modern criteria are used, early diagnosis made, and early operative treatment instituted that the woman with chorio-epithelioma will have approximately a 95 per cent chance to get well and keep her ovaries.

ALBERT MATHIEU.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE first edition of Cowdry's book[1] on histology departed radically from the traditional type of student text. In the opinion of the reviewer, it blazed a new trail in demonstrating the possibilities of histological presentation on a correlated, functional basis. But by the very nature of the case such treatment has its practical handicaps. If it combines morphological description with functional exposition, then one or both must suffer unless the book attains undue size. This has been Professor Cowdry's problem from the outset and he has met it courageously, and without wavering from several unorthodox pedagogical convictions. He believes that most textbooks waste space with the obvious; that preliminary instruction on the cell and fundamental tissues is unsound and unnecessary; that a histological text should be built around the blood vascular system as the great integrator. These citations alone will illustrate how unusual is the plan and content of his book.

In the present edition some concessions have been made to friendly criticisms. A historical and orienting introduction now is included. Many figures have been added to illustrate normal variations upon which depend degrees of physiological activity. More attention has been given to bridging the gap between gross and microscopic anatomy, and the abundant inclusion of contemporary research has been extended and controversial subjects aired.

It would seem that this book will still be difficult for the tyro who arrives at medical school and must plunge forthwith into the curricular maelstrom. Probably most teachers doubt their students' capacity to assimilate such strong diet. Just possibly it is the teachers who are at fault by being overtimorous. But the hours available to histology are so few that it would seem the wisest course to many to use them in instilling first the tried fundamentals and then presenting as much of contemporary trends and physiological interpretations as may be possible. Yet no serious medical student should be without access to this stimulating and informative book. From it he will gain an insight into science in the making, learn to do correlative thinking and be disillusioned as to the existence of dogmatism even in what at first might seem a stabilized subject. As a companion reference the book is ideal. It is difficult to restrain one's enthusiasm in recommending Professor Cowdry's text to the alert clinical practitioner. If his histology dates back more than ten years, he will be astonished at the meagerness of his concepts of modern histology as made to live through the pen of one of America's acknowledged master histologists.

L.B.A.

THIRTEEN successive editions of Osler's *Principles and Practice of Medicine*[2] have faithfully recorded progress over a period of 46 years, the most fruitful in the history of medicine. Eight editions were prepared by Osler, himself, and four by McCrae. Now Christian, a pupil of Osler and a friend and colleague of McCrae carries on the tradition. The original work, in 1892, met with such success that it immediately superseded all other textbooks of general medicine. Cushing, in his classical biography of Osler, wrote that the volume was "what might be called a practical pathology in which were given the results of modern investigation, microscopical, bacteriological, and chemical. On their foundation was built up the symptomatology and diagnosis of disease and where a specific form of treatment was known to avail it was given its due prominence. Otherwise there were few recommendations beyond giving a chance to Nature aided by proper nursing and hygiene." Credited as indirect results of this work and its author's honest skepticism concerning drugs are the establishment of the Rockefeller Hospital and the interest in the prevention and cure of disease shown by the General Education Board. The influence on medical students has been incalculable.

Christian's revision is an admirable achievement. It continues successfully the traditions of his predecessors, "attuning them to such newer knowledge in the field as has developed by means of rearrangement, rewriting and the addition of new material." The book remains exceptionally readable, authoritative and concise and will continue to "hold the field." The new edition contains 1,424 pages as compared with 1,079 in the original. In the opinion of this reviewer, the Osler-Christian book still enables the medical student, better than does any other text, to effect a transition from pre-clinical subjects to clinical medicine. The practitioner will find it readable, compact, and authoritative, conservative and adequate but not usually detailed as regards treatment. Of volumes by one author it has, in the opinion of the reviewer, no peer although texts containing articles by many different authors are available that may be more informative to the practitioner.

WALTER H. NADLER.

[1] A TEXTBOOK OF HISTOLOGY; Functional Significance of Cells and Intercellular Substances. By E. V. Cowdry. 2d ed., rev. Philadelphia: Lea & Febiger, 1938.

[2] THE PRINCIPLES AND PRACTICE OF MEDICINE; Designed for the Use of Practitioners and Students of Medicine. Originally written by the late Sir William Osler; revised by Henry A. Christian, M.D., LL.D., S.D., F.R.C.P. 13th ed. New York and London: D. Appleton-Century Company, Inc., 1938.

THE fourth edition of Boyd's *Surgical Pathology*[1] exhibits no departure from the highly satisfactory method of presentation found in the preceding editions. The treatise is divided into thirty-seven chapters which are carefully selected, and comprise practically all of the more commonly encountered diseases in the realm of surgery. An interesting introductory chapter on surgery and pathology, omitted for the first time from the third edition, has been reinserted. Included among the new subjects are lymphogranuloma inguinale, primary thrombosis of the axillary vein, glomus tumor, pilonidal cyst, Hashimoto's disease, parathyroid tumor, regional ileitis, the pathology of the intervertebral discs, Gradenigo's syndrome, and tumors of the islets of Langerhans.

The rewriting of the chapter on diseases of the rectum has vastly improved the section on ulcers and fistulas. The pathogenesis of these conditions is discussed in a manner quite commensurate with the contemporary understanding of the subject. In the chapter on appendicitis, considerable attention is paid to the work of Wangensteen and Bowers demonstrating that obstruction plays an all important rôle in appendicitis. The author declares that in recent years much progress has been made in the study of neoplasia. He points out the significance of the phenathrene ring in the experimental production of cancer. New material is also included on the relation of the hypothalamus to gastric ulcer, the pathogenesis of renal calculi, and the relation of chronic mastitis to carcinoma of the breast.

No effort is made to have the experimental work on any subject complete. The author, instead, carefully selects what, in his opinion, is significant. By this method the material is brought quite well up to date, and the size of the book is prevented from becoming unreasonable. The text reads easily and is very fresh and alive, due most probably, to the discussions on pathologic physiology. This is correlated with the gross and microscopic pathology and the symptomatology in such a way as to make an extremely elucidating and interesting work. The author's style is direct and concise and possesses unusually good literary form for a medical book. The volume should certainly be in the library of every surgeon and pathologist. ALEXANDER SLIVE.

EVERYONE who has used carbon dioxide and oxygen for therapeutic purposes should read Henderson's *Adventures in Respiration*.[2] Why? Because the book is written by the discoverer of the therapeutic use of carbon dioxide and oxygen in such a clear and interesting manner that every physician and medical student can comprehend and enjoy reading the facts regarding the acapnia theory, the theory upon which the therapy is based. It is only with such information in mind that the therapy can be most rationally used. The author's method of "resuscitation from asphyxia" has undoubtedly saved many lives. The facts upon which this accomplishment is based are presented truly as the author states, "as a simple story of adventures: adventures in respiration as I have myself experienced and enjoyed them." A. C. IVY.

PROCEDURES for practically all situations in plastic surgery are included by Barsky in his recent book[3] and, according to the preface, these procedures have been evaluated and have been successful in his hands and the hands of his colleagues. The usual diagrams of methods of closure of small defects are outlined along with type of anesthesia used. The section on free skin grafts lacks photographs of results obtained which would make the text inadequate were it not for the fact that further details of grafting appear under other chapter headings. One is especially surprised in examining the diagram showing the thickness of various grafts to find that the same mistake has been made as in other texts: for example, a split or thick Thiersch graft is shown being cut through the basal layer of the epidermis. The author states in the text, however, that the split graft is cut one-half to three-fourths the thickness of the skin. Apparently he has not correlated this statement with the mistaken idea shown in the illustration.

An upper lip mucous membrane flap is recommended for a small vermilion loss on the lower lip but no mention is made of the method employed by New and others, simply to mobilize the mucous membrane on the inside of the same lip and advance it. In the chapter on jaws, the subcutaneous section of the ramus for retrusion is credited to Padgett instead of to Blair.

Nose operations are quite fully described and there is a wealth of material in the book, but one might surmise that the subject of plastic surgery needs a larger text if the entire field is to be covered. The book should receive a good reception by the increasing demands of surgeons who find it difficult to obtain the scattered articles in the literature that describe the procedures now in general use.

JAMES BARRETT BROWN.

THE authors—professor and associate professor, respectively, of pathology in Temple University School of Medicine—of *Essentials of Pathology*[4] present what they consider fundamental and essential in pathology by a new method. In general outline, the familiar and orthodox division into general pathology, tumors, and systematic or special pathology is followed. But within the several chapters "a concise discussion" of each specific pathological condition or disease is followed by one or more "carefully

[1] SURGICAL PATHOLOGY. By William Boyd, M.D., LL.D., M.R.C.P. (Ed.), F.R.C.P.(Lond.), Dipl. Psych., F.R.C.S. 4th rev. ed. Philadelphia and London: W. B. Saunders Co., 1938.

[2] ADVENTURES IN RESPIRATION: Modes of Asphyxiation and Methods of Resuscitation. By Yandell Henderson. Baltimore: Williams and Wilkins Co., 1938.

[3] PLASTIC SURGERY. By Arthur Joseph Barsky, M.D., D.D.S. Philadelphia and London: W. B. Saunders Co., 1938.

[4] ESSENTIALS OF PATHOLOGY. By Lawrence W. Smith, M.D., and Edwin S. Gault, M.D. With a foreword by James Ewing, M.D. New York and London: D. Appleton-Century Company, Inc., 1938.

selected case histories, complete with their associated gross and microscopic pathology." Dr. James Ewing in his foreword expresses the belief that this case history method is one of the most successful of the "various devices" that "have been employed to take the teaching of pathology out of the realm of abstract philosophy and make it an effective force in the professional equipment of the medical student." This method of the clinicopathological conference has been employed in teaching of junior and senior medical students and graduate physicians for many years, but this is the first attempt to use it in presenting the first or elementary course in pathology. How successful this method will prove in this new field remains to be seen. It should yield satisfactory results for it does possess advantages. In the first place it gives pathology a practical value—an expression that has a large appeal to medical students and graduate physicians. The clinical history with the essential, associated and adventitious pathological changes in each case impresses the student with the fact that any one section represents only a part of the entire disease process and thus enables him to gain a broader concept of pathology and its relation to the science and art of medicine. The descriptions of microscopic pathology in specific cases should by example aid students in making adequate records of their own observations in studying and describing their own microscopic slides.

A certain amount of the philosophic basis and general principles of pathology must be presented if the student is to acquire an adequate knowledge of the clinical side of medicine and is to meet successfully the serious emergency problem of passing state and national board examinations. For he who can "load his facts on the wheels of theory" will be able to carry more facts than if he has to handle each one in an isolated package. In general, the concise discussion of each subject in this volume is perhaps adequate for both these purposes. In some instances, for example, the explanation of the mechanisms of the different types of edema on page 46, the discussions are too brief to meet these requirements.

Certain sections merit special commendation. The important tropical diseases and those due to animal parasites are treated in an especially satisfactory manner. "Tumors are likewise emphasized to a rather greater extent than is customary." The general discussion of this subject covers 163 pages with 133 illustrations. The authors insist that "cancer is not a single disease but a generic term applied to a variety of conditions of different etiology, running typical specific courses, affecting particular organs and tissues, and having but one property in common—the autonomous new growth of cells." The leucemias (pp. 300–308) and Hodgkin's disease (pp. 295–296) are placed frankly among the malignant tumors. The statement that in Gruskin's test (intracutaneous injection of extracts of certain fetal tissues) for carcinoma and sarcoma "well over 90 per cent accuracy has been established" (p. 229), will doubtless meet with considerable skepticism. Satisfactory discussions, excellent illustrations and interesting case reports of the rare tumors of the ovary—arrhenoblastoma, granulosa or theca cell carcinoma, and Brenner's tumor—are given on pages 717–720. But there is no description of the changes in the endometrium during the various phases of the menstrual cycle.

This volume contains 865 pages of text with 679 illustrations, reports of 295 cases, and an adequate index of 18 pages arranged in three columns to the page. The typography is excellent with the case reports in small but clear type. The pages measure 8½ by 11 inches and are therefore larger than those of most textbooks. But the printed material is arranged in two parallel columns each 3 inches wide and this makes for easier reading. The illustrations—gross specimens, roentgenograms and photomicrographs—are, on the whole, excellent. Reproductions of the 12 colored plates are worthy of special notice.

The numerous carefully selected illustrative clinical histories with microscopic, and, in many cases, gross and x-ray, illustrations of each case, together with the rather more than usual success in correlating clinical and pathological findings should render this volume both useful and interesting to clinicians and medical students alike. J. P. Simonds.

DR. KARSNER'S textbook *Human Pathology*,[1] first printed in 1926, now appears in a fifth edition, following the fourth edition after an interval of 4 years. That the book should go through five editions in the 12 years since its first appearance, and its continuous inclusion among the texts recommended for students in most of our medical schools, indicates that Dr. Karsner's text is accepted by his pathologist colleagues as well as by others as a reliable and useful book.

Though the book is designated as a new edition, there are but few changes. It could, perhaps, as well be designated a "revision" as a new edition. Little new material has been added. While it is stated in the preface that "no chapter has escaped alteration," in many of the chapters the alterations consist of a few changed words or sentences. A few paragraphs have been rewritten.

Physically the fifth edition is practically identical with the fourth. The arrangement of material and chapter sequence remains unaltered. A few unnumbered photomicrographs are added, and some new illustrations are substituted for old ones. The text continues to be well illustrated. The bibliography has received revision, and continues to be excellent.

Dr. Karsner's gross and histopathological descriptions are concise, clear, and effective. While anatomic changes are clearly presented, too often an equally clear concept of the disease as an entity of disordered physiology does not emerge. This apparently too exclusively anatomical viewpoint is further stressed

[1] Human Pathology: A Textbook. By Howard T. Karsner, M.D. With an introduction by Simon Flexner, M.D. 5th ed., rev. Philadelphia and London: J. B. Lippincott Company, 1938.

by the organization of the book; for example, rickets is considered as a disease under the chapter heading "Organs of Locomotion." Nowhere in the discussion is its essentially general and systemic nature emphasized.

One could differ with the author in certain particulars, such as the statement on page 917 that in trichinosis, the nausea, diarrhea and fever probably result from "absorption of poisonous products released by the digestion of the cyst wall of the larvæ." Only by a very liberal inclusiveness under the term "poisonous products" could this statement be supported. Again, one could wish for more complete discussion in many of the subjects under systemic pathology. For example, in the paragraph devoted to Paget's disease of the nipple, no mention of the occurrence of extra-mammary Paget's is made.

Despite criticisms of this type, the student will find this book, as in the past, an excellent introductory text to pathology. The gross and microscopic descriptions of lesions are objective and clear cut. Important physiological correlations are discussed, and statistical considerations are not neglected. The bibliography is comparable to that in many reference works. This edition continues to fulfill well the purpose for which it was written—a text for students.

Whether the book will fill the practitioner's needs as a reference in pathology probably depends largely upon the amount of knowledge of pathology already possessed by the individual concerned. One book cannot very well serve both as an introductory text for students in pathology and as a reference work. The practitioner's choice between this and the other standard American and English texts will probably depend, as in the past, largely upon his personal preferences in such matters as style, textual emphasis, and arrangement, and clinical correlation.

F. B. QUEEN.

THE text[1] by Reed, Emerson, and Mumford is a discussion of the relation of injury to diseases. In all the diseases considered they state whether trauma is or is not a factor. This is a difficult problem and at times the authors must necessarily be dogmatic. They are and admit it. To surgeons who have had considerable experience in traumatic surgery their conclusions will be seen to be sound and their judgment mature. This book will be of value to surgeons in industry, to casualty and insurance men, and to arbitrators in state industrial courts, who would not go far wrong in respecting the conclusions given. The presentation of the relation between trauma and malignancy is based upon a study of cases rather than upon the usual method of blindly following textbook theoretical views. The book would be useful in medico-legal trials and is so written that lawyers and other non-medical persons may readily grasp the subject material.

GEORGE G. DAVIS.

[1] THE RELATION BETWEEN INJURY AND DISEASE. By Jewett V. Reed, B.S., M.D., F.A.C.S., Charles P. Emerson, A.B., M.D., D.Sc., and E. B. Mumford, B.S., M.D., F.A.C.S. Indianapolis, Ind.: The Bobbs-Merrill Company, 1938.

THE new volume[2] by Wallace Mason Yater has been designed primarily for the introduction of students to the subject of internal medicine. Yater's intention of presenting the minimum amount of knowledge a medical student or general practitioner should have at his finger-tips will be difficult of realization since there are 1,002 pages divided into 21 sections which include chapters on diseases of the nervous system, mental diseases, and diseases of the skin, ear and eye, as well as a final section on dietetics. The services of twelve contributors have been enlisted.

The book is up to date, eminently practical, and the least conventional of recent texts on medicine. The opening section is devoted to diseases of the heart. A table of contents at the beginning of each section is designed to serve as a classification. Particularly commendable is the general introduction to each subject. Key phrases and conclusions are printed in heavy type. Summaries of the main symptoms and signs are listed in one, two, three order. Tables of differential diagnosis are included. Another innovation is the use of 225 well selected illustrations. Treatment receives much more attention than in the average text. Functional tests and the technique of diagnostic procedures are clearly explained. Material is presented that is usually found in books on physical diagnosis and therapeutics. Reference is made at the end of each section to various recommended texts and monographs but rarely to articles in journals.

The method of approach emphasizes the practical points in diagnosis and treatment, but sacrifices the natural method, so successfully employed by Osler, of basing the clinical picture on pathological or biochemical changes already familiar to the student. Emphasis of the practical inevitably leads to observations that are slightly dogmatic or at least somewhat misleading, as for example the statements that "electrocardiography is not an indispensable method in the practical diagnosis and management of cardiac disease and heart failure but is a very important adjunct" and that in diabetes "it is necessary at the outset to determine the exact severity" of the disease. In conjunction with a more conventional text, this book should be of value to the student in crystallizing clinically important data. To the practitioner it may be even of greater assistance.

WALTER H. NADLER.

THE co-operative work of the members of the department of bacteriology, public health and preventive medicine of Boston University School of Medicine is presented in *A Textbook of Medical Bacteriology*.[3] The stated purpose is to present the subject in a comprehensive yet condensed form for the medical student and the practicing physician.

[2] THE FUNDAMENTALS OF INTERNAL MEDICINE. By Wallace Mason Yater, A.B., M.D., M.S. (Med.). New York and London: D. Appleton-Century Company, Inc., 1938.

[3] A TEXTBOOK OF MEDICAL BACTERIOLOGY. By David L. Belding, M.D., and Alice T. Marston, Ph.D. New York and London: D. Appleton-Century Company, Inc., 1938.

The usual aspects of bacteriology and immunology are treated together with a section on sanitary and economic bacteriology including short instructive chapters on bacteria of the air, water, sewage and trade wastes, agricultural bacteriology, milk, food bacteriology and industrial bacteriology.

The subject matter is well organized and presented in a concise and very readable manner. However, for the uninitiated this conciseness tends to increase the difficulty of understanding the subject and combined with the presentation of only one aspect of controversial subjects to increase the difficulty of evaluation and interpretation. As a teaching text considerable class room elaboration would be required; while for the practicing physician, whose time for study is limited, the book would serve as a good outline review. Especially to be commended is the section on the pathogenic fungi, that confused but important group of micro-organisms.

A. A. DAY.

THE recent book *Diseases of Women*[1] is readable, clear, and understandable. The descriptions are simple and no chapter is too complex. The photomicrographs are not very good and the drawings only fair. The chapter on endocrinology is slightly out of date, nevertheless it is simple and easily understood. The chapter on cancer of the cervix is short and not sufficiently detailed, but it is satisfactory for the general practitioner. The new tumors of the ovary are not well described. The arrhenoblastomas occupy but six lines, and granulosal cell tumors only one short paragraph. A greater detailed description of these modern types of tumors should be presented in a book on gynecological pathology.

This book can be recommended to surgeons and general practitioners but would not be satisfactory to most gynecologists. JOE VINCENT MEIGS.

[1] DISEASES OF WOMEN. By ten Teachers. Under the direction of Clifford White, M.D., B.S.(Lond.), F.R.C.P.(Lond.), F.C.O.G. Edited by Sir Comyns Berkeley, Clifford White, and Frank Cook. 6th ed. Baltimore: William Wood & Co., 1938.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE PATIENT IS THE UNIT OF PRACTICE. By Duane Willard Propst, A.B., B.S., M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1939.

VIAJE DE UN CIRUJANO. By Conrado Zuckermann. Mexico City: Union Tipografica Editorial Hispano-Americana, 1938.

LANDMARKS IN MEDICINE; LAITY LECTURES OF THE NEW YORK ACADEMY OF MEDICINE. Introduction by James Alexander Miller, M.D. New York and London: D. Appleton-Century Co., Inc., 1939.

WILLIAM B. WHERRY; BACTERIOLOGIST. By Martin Fischer. Springfield, Ill.: Charles C. Thomas, 1938.

ST. THOMAS'S HOSPITAL REPORTS. Edited by Prof. O. L. V. S. De Wesselow, and Mr. C. Max Page, with the assistance of Mr. N. R. Barrett, Dr. J. St. C. Elkington, and Dr. A. J. Wrigley. 2d series, vol. 3. London: St. Thomas's Hospital, 1938.

OH, DOCTOR! MY FEET! By Dudley J. Morton, M.D. New York, London: D. Appleton-Century Co., Inc., 1939.

ANNALS OF ROENTGENOLOGY; A SERIES OF MONOGRAPHIC ATLASES. Vol. 17—Roentgen Diagnosis of the Extremities and Spine. By Albert B. Ferguson, M.D. New York: Paul B. Hoeber, Inc., 1939.

LEHRBUCH DER FRAUENHEILKUNDE. By Prof. Dr. W. Weibel. Vol. 2—Gynaekologie. Berlin and Vienna: Urban & Schwarzenberg, 1939.

CHRONIC DISEASES OF THE ABDOMEN; A DIAGNOSTIC SYSTEM. By C. Jennings Marshall, M.S., M.D.(Lond.), F.R.C.S.(Eng.). Boston: Little, Brown & Co., 1939.

TRANSACTIONS OF THE AMERICAN GYNECOLOGICAL SOCIETY. Vol. 63 for the Year 1938. Edited by Richard W. Te Linde, M.D. St. Louis: The C. V. Mosby Co., 1939.

SURGICAL ANATOMY. By C. Latimer Callander, A.B., M.D., F.A.C.S. With a foreword by Dean Lewis, M.D., Sc.D., LL.D., F.A.C.S. 2d ed. Philadelphia and London: W. B. Saunders Co., 1939.

MODERN SURGICAL TECHNIC. By Max Thorek, M.D., K.L.H.(France); K.C.(Italy). With a foreword by Donald C. Balfour, M.B., M.D.(Tor.), LL.D., F.A.C.S., F.R.A.C.S. Vols. 1, 2, 3. Philadelphia, London, Montreal, New York: J. B. Lippincott Co., 1939.

SURGICAL TREATMENT OF HAND AND FOREARM INFECTIONS. By A. C. J. Brickel, A.B., M.D. St. Louis: The C. V. Mosby Co., 1939.

OXFORD MEDICAL PUBLICATIONS. THE EVOLUTION OF OBSTETRIC ANALGESIA. By Andrew M. Claye, M.D. (Leeds), F.R.C.S.(Eng.), F.C.O.G. With a chapter by W. Stanley Sykes, M.A., M.B., B.Ch.(Cantab.), D.A. London, New York, Toronto: Oxford University Press, 1939.

PULMONARY TUBERCULOSIS; A SYNOPSIS. By Jacob Segal, M.D. Foreword by the late Pol N. Coryllos, M.D., F.A.C.S. New York, London, Toronto: Oxford University Press, 1939.

CONSOLIDATED INDICES. Embracing Transactions of the American Roentgen Ray Society (1903–1908); American Quarterly of Roentgenology, Vols. I–V (1906–1913); American Journal of Roentgenology, Vols. I–IX (1913–1922); American Journal of Roentgenology and Radium Therapy, Vols. X–XXXVIII (1923–1937). Author and Subject: 1903–1937. Compiled under the direction of the Publication Committee and the Editorial Office of the American Roentgen Ray Society. Springfield, Ill.: Charles C. Thomas, 1939.